 IN TWO SECTIONS—SECTION ONE

MECHANICAL ENGINEERING

INCLUDING THE ENGINEERING INDEX

THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS

IN THIS NUMBER

JANUARY 1921

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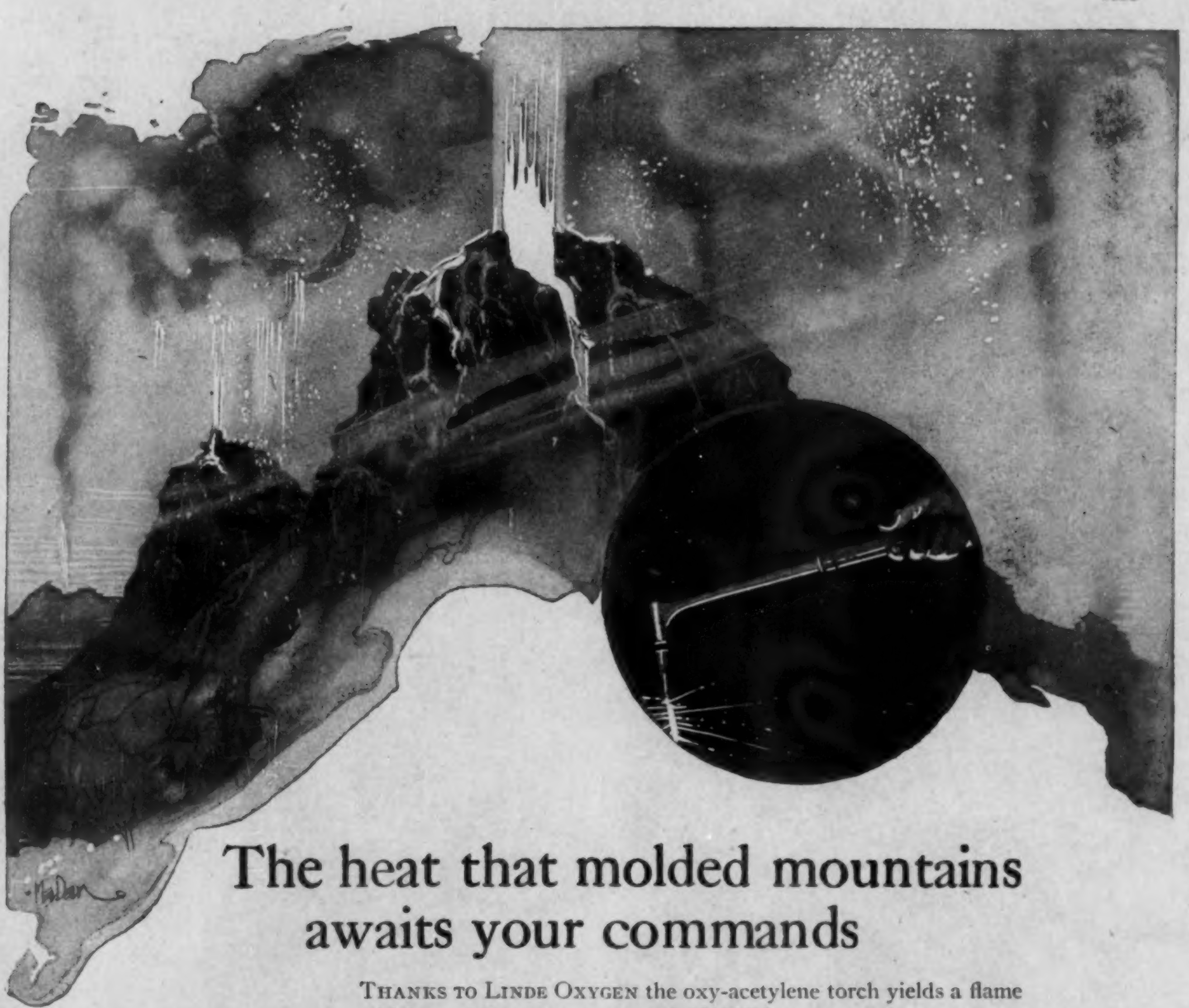
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Mechanical Engineering

The Monthly Journal Published by

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Contributors and Contributions

Transportation Problems

Probably the best-known man in the railroad world today is Daniel Willard, president of the Baltimore and Ohio Railroad. Noted for his broad knowledge of railroad work and his ability to place his finger on troublesome points, his paper in this issue of MECHANICAL ENGINEERING contributes to the increase of general knowledge of railroad problems, and carries weight in their solution.

DANIEL E. WILLARD

Charles A. Morse, who presented a paper on Feeders for Railroads, is chief engineer of the Chicago, Rock Island and Pacific Railroad. Mr. Morse has served as chief engineer for the Santa Fe System and was assistant director of operation in charge of maintenance of way for the United States Railroad Administration during the war.

Col. William Barclay Parsons has had an interesting engineering career. His important work has been the supervision of the New York City subway construction, but his experience and reputation are international as he conducted railway surveys in China and served on the Isthmian Canal Commission and as advisory engineer of the Royal London Traffic Commission. During the war he headed the 11th Regiment of Engineers, whose notable railroad work has been widely heralded. Colonel Parsons, the author of the paper on Terminals and Terminal Yards, is also chairman of the Board of Trustees of Columbia University.

Engineers and Service

The Federated American Engineering Societies has summoned engineers to service. It is significant and fitting, therefore, that Major Miller's presidential address should discuss some phases of the service that engineers, by analysis and study of the underlying facts and fearless presentation of the resulting conclusions, can render in these troublous times. President Miller spoke with the conviction coming from a lifetime of service experience and his address, appearing as the leading article in this issue, merits careful thought by all engineers who desire to keep their fingers on the pulse of the times.

Fuel Conservation

Everyone agrees that fuel should be saved, but the determination of a policy of conservation is another matter. The Fuel Section of the Society talked this matter over in three sessions totaling ten hours at the recent Annual Meeting and the papers that started the discussion are printed in this issue. These are Fuel Supply of the World, by L. P. Breckenridge, professor of mechanical engineering, Sheffield Scientific School, New Haven; Fuel Conservation: The Need for a Definite Policy and its Requirements, by David Moffat Myers, consulting engineer, Griggs & Myers, New York; Distillation of Fuels as Applied to Coal and Lignite, by O. P. Hood, chief mechanical engineer, U. S. Bureau of Mines, Washington, D. C.; and Form Value of Energy, by Chester G. Gilbert, consulting engineer for Arthur D. Little, Inc., Washington, D. C., and Joseph E. Pogue, industrial economist and engineer, Sinclair Consolidated Oil Corporation, New York.

Power Test Codes

In this issue is included the second of the results of the Power Test Codes Committee's work, the Test Code on Reciprocating Steam Engines. The first, a Code on General Instructions, appeared in the December issue of MECHANICAL ENGINEERING. In subsequent numbers the Test Code for Evaporating Apparatus, Test Code for Reciprocating Displacement Pumps and the Test Code for Boilers will be printed.

The Code on Reciprocating Steam Engines is published for the entire membership of the Society. Comments received on this Code will be sent to the Sub-Committee preparing it and after their reconsideration the Code will be referred to the Council for final adoption.

A.S.M.E. Annual Meeting Papers

The Annual Meeting this year showed a slightly larger attendance than the 1919 meeting, which had the largest previous attendance. A study of the account of the meeting appearing in this issue of MECHANICAL ENGINEERING will bring out as the main point of interest the great variety and value of the professional sessions.

Mr. Earle Buckingham, who presented a paper at the Machine Shop Session on the Side-Cutting of Thread-Milling Hobs, is engineer of Standards at the Pratt & Whitney Company.

The Railroad Section is pledged to the consideration of the mechanical problems in railroad operation and at its Annual Meeting Session two papers, printed in this issue, bearing on the important phases of railway problems were presented, the paper on Modern Locomotive Terminals by George W. Rink, assistant superintendent of motive power of the Central Railroad of New Jersey, and the paper on Increasing the Capacity of Old Locomotives by C. B. Smith, mechanical engineer of the Boston & Maine Railroad.

The Textile Session at the Annual Meeting brought out three interesting papers, one of which, Power Applications to Cotton-Finishing Plants, was prepared by Leo Loeb, of Day & Zimmermann, Philadelphia. The Day & Zimmermann Company have had considerable experience in the constructing of cotton-finishing plants and Mr. Loeb has been in close touch with this work.

A.S.M.E AFFAIRS

Section Two of this issue of MECHANICAL ENGINEERING is overflowing with interesting details of the Society's work—committee reports indicating broad scope of activities, local sections meetings, and announcements of professional section plans.

Spring Meeting - - Chicago
May 23-26, 1921

MECHANICAL ENGINEERING

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The Engineer's Service to Society

Presidential Address at the A.S.M.E Annual Meeting, 1920, Dealing with the Influence of the Engineer in Constructive Adjustment—Property Rights and Human Rights—Relations Between Employer and Employee

By FRED J. MILLER, CENTER BRIDGE, PA.

IN what turned out to be his inaugural address as President of The Federated American Engineering Societies at its first meeting held in Washington last month, Herbert Hoover said many things that showed very clearly the long distance we have traveled within recent years in our search for industrial peace and industrial efficiency.

Speaking of the part being and to be taken by engineers in this movement and after referring to the grave dangers that may result from contention and warfare between the various economic groups, each seeking to promote its own interests, he said:

> The engineers should be able to take an objective and detached point of view. They do not belong to the associations of either employers, or of labor, of farmers, of merchants, or bankers. Their calling in life is to offer expert service in constructive solution of problems, to the individuals in any of these groups. There is a wider vision of this expert service in giving the group service of engineers to group problems.

Further on he said:

> The employer sometimes overlooks a fundamental fact in connection with organized labor in the United States. This is that the vast majority of its membership and of its direction are individualists in their attitude of mind and in their social outlook; that the expansion of socialist doctrines finds its most fertile area in the ignorance of many workers, and yet the labor organizations, as they stand today, are the greatest bulwark against socialism. On the other hand, some labor leaders overlook the fact that if we are to maintain our high standards of living, our productivity, it can only be in a society in which we maintain the utmost possible initiative on the part of the employer; and further, that in the long run we can only expand the standard of living by the steady increase of production and the creation of more goods for division over the same numbers.
>
> The American Federation of Labor has publicly stated that it desires the support of the engineering skill of the United States in the development of methods for increasing production, and I believe it is the duty of our body to undertake a constructive consideration of these problems and to give assistance, not only to the Federation of Labor but also to the other great economic organizations interested in this problem, such as the employers' associations and the chambers of commerce.

Last March, speaking before the Chamber of Commerce at Boston, he said:

> We must surround employment with assurance of just division of production. We must enlist the interest and confidence of the employees in the business and in business processes. To do these things requires the coöperation of labor itself, and to obtain coöperation we must have intimate organized relationship between employer and employee. They are not to be obtained by benevolence. They can only be obtained by calling the employees to a reciprocal service.

In a story published in one of our magazines last year, the author, Ellen N. La Motte, remarked: "The ability to perceive the obvious is a rare and disconcerting gift."

I wish to call your attention to some obvious things; not only because they are related to, or intimately connected with, the work of the engineer, but also because I believe that engineers in general have more than some others this rare and sometimes disconcerting gift.

It is clear that ours is the professional society of the industries, none of which are or can be carried on without the work of the mechanical engineer, who not only provides the machinery, but also plans the plant and organizes and manages the force of workers.

The engineer must increase the effectiveness of labor, not by driving, by oppression, or suppression—the education and training of the engineer are not needed for that—but by the application of brains in industrial organization and management of men as well as of materials.

A certain deservedly popular railroad president, now retired, used often to say, in his charming after-dinner speeches, that the humblest employee of his road might aspire to its presidency. Thereupon we were regaled by a new broadside of editorials based upon the assumption that the man tamping ties ten hours per day at a wage of $1.10 had no cause for complaint, because not being president of the road at a salary of $50,000 per year was entirely his own fault. We have gotten past that sort of thing because it is clearly seen that if we are to have railroads some one must tamp ties and the welfare of the tie tamper is the concern of the public, especially where the man is an actual or potential citizen and is able not only to express his dissatisfaction in his vote but to pass on to his children his attitude toward the industrial and social organization.

We must face the fact that so far as we can see a large proportion of working people must continue throughout their lives to work, under the direction of others, at tasks intrinsically wearisome and distasteful; and when accompanied by long hours, harsh treatment and wages below the standard of comfortable family maintenance, actually dangerous to our social well-being.

We must remember also that in matters which concern the public welfare and with regard to the general policy to be followed by the nation all must have a voice, including now the women of the nation. It will be a mistake for those who direct industries or who take part in them in any capacity, to assume that the conscience of the nation will not assert itself upon the social effect of misdirected industrial activity.

It is not a misfortune that it does so, annoying as it sometimes appears to be, for it distinctly leads to the maintenance of a proper standard of civilized existence and also tends to protect the fair, enlightened and public-spirited employer from the unfair competition of the other kind of employer.

No one class may safely control in matters of public policy, but all may safely do so, and unless all do, there will be little chance of permanent stability or security.

Our Past-President, Doctor Hollis, has characterized different periods of history as:

The 17th century, the period of exploration
The 18th century, the beginning of religious tolerance
The 19th century, the sowing of the seeds of democracy
The 20th century, the period of crowded invention, and this
The 21th century, the period of adjustment.

If this is correct, as I believe it is substantially, then I hope and believe that the influence of the engineer will be in the direction of constructive adjustment—such an adjustment as will show recognition of the fact that there are both property rights and human rights, and that if human rights are, as Lincoln declared them to be, superior to property rights, then it is still to be remembered, nevertheless, that security of all genuine property rights is a necessary condition of human rights.

The improvement of the human race that is always going on takes many different directions and goes forward in many different fields. The engineer shares with his fellow human beings the results of the efforts of others, and his own peculiar contribution to the cause of human progress must always continue to be an

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increasing power to control the forces and modify the materials of Nature for the benefit of mankind. A very important part of this work is what we term the problem of industrial relations, which, it is certain, can never be satisfactorily solved except by the methods of the engineer; and it is equally certain that it can never be settled until settled right; that is to say, not until all concerned—the employed, the employer and the public—are convinced that substantial justice has been secured and is being maintained.

Of course there are and always have been employers who have been fair toward their employees—have been real leaders of men, able to arouse and maintain enthusiastic coöperation. Notable successes have been founded mainly upon this human ability or quality. In too many cases, however, the most profound thought that seems to have been applied to an industrial problem has led to the conclusion that industrial management consists in hiring as cheaply as possible and driving as hard as possible.

The day for that sort of thing is passing and industry generally is beginning to be conducted upon a much higher plane of intelligence. It is being recognized that there is a science of industrial management. Engineers have, so far, developed and formulated it; they must go on with it and conduct the country's industries in accordance with it, recognizing that the old order has passed away. Management of an industrial group is not a matter of brute force, but of intelligent skill, fairly and sympathetically applied with a view to getting the best possible results, not only for the employer, but for the workers and for the public as well.

If research is important in physics and in chemistry it is at least equally important in the domain of industrial science, and when fundamental facts or laws have been made known by such research we must face them; not to do so may mean disaster.

In general, the engineer bases his opinion and his acts upon definitely ascertained and carefully studied facts. We must do the same in our industrial-management problems, and when we do, most of our industrial difficulties disappear.

I have myself known of a large factory, believed by its owners to be well managed, but in which among the employees there was much unrest, much distrust of the management, general bad feeling and lost motion, to be transformed completely under the influence of new management with an enlightened policy and a plan which included no spies nor underhanded methods of any kind, but instead, methods of correcting administrative faults, for helping every employee to be successful with his work and to earn as well as receive high wages.

The better spirit that pervaded the place was remarkable and was reflected not only in greatly improved human relations, but also in greatly reduced labor costs and in the total cost of goods produced, while at the same time the employees earned substantially more money, usually without greater effort than before and sometimes with less effort than before.

We have been hearing a great deal about a falling off in production per man-hour, and there has been a good deal of that. But the fact is that too many of our industrial establishments have been conducted upon the hire, drive, and "fire" plan. I am speaking now of industries in general and of all kinds, not solely of the engineering industries with which we are best acquainted.

In ordinary times when there are more men looking for jobs than there are jobs, that method will answer, though it is never a good method. Men will stand for more or less harsh and unsympathetic treatment when not to do so may mean deprivation for themselves and those dependent upon them.

But in times such as those we have been passing through that method breaks down and the difference between real leaders of men and mere ignorant drivers becomes apparent. There are establishments in which the output per man-hour has not decreased and some in which it has been all along greater than in the prewar period. Some have of course been favored, others hampered by exceptional circumstances, and the necessity of replacing with new help, those who were called for military duty tended strongly to reduce efficiency, in some industries much more than in others. But in general, those who suffered least in that respect were those whose policy was and had been an enlightened and intelligent one rather than the opposite, as indeed we should expect would be the case.

Contact Between Employer and Employee

Too often "results" are demanded by financiers and others who know little or nothing of industrial matters—who are far distant from the locality where the work of production is carried on and ask no questions as to methods, or whether of two local executives producing equal results so far as the books show, one has built up confidence and good will while the other has bred distrust and hatred among the body of employees.

Unfortunately morale and esprit de corps are not itemized on balance sheets, and some of those who are at the head of large manufacturing concerns know little or nothing about manufacturing except balance sheets prepared by men who also know little or nothing of management science and do not suspect that there is any such thing.

The growing number of engineers who stand high in the councils of large manufacturing concerns gives promise of better things in this respect.

In the older and simpler times when the workers very generally came into direct contact with those who were to use what the workers produced, the workers could not forget that they were rendering service to the public; nor could the public forget or overlook that fact. While those who work are today just as truly rendering service to the public, we have between the worker and the consumer whom he serves, a retail merchant, a jobber or wholesaler, the directors of transportation systems, a board of directors with its officers, a superintendent and a foreman.

The foreman is usually the only link in this long chain that the worker knows much about. This would seem to make plain the fact, repeatedly proved by experience, that our foremen should be provided with the machinery, so to speak, of true leadership and then carefully and systematically selected and trained for such leadership. That is a part of the work of the industrial engineer.

It is becoming generally recognized that, whether or not the head of a large industrial corporation will upon request confer with his employees, any group of them, or any freely chosen representative of them, about conditions of employment and of living, is not a question between him and his employees solely, but that the general public may be and often will be interested in the matter. A corporation is created and exists by authority of the people; they may depend upon it for imperative necessities of modern civilized existence; they are responsible for the maintenance of law and order in times of industrial warfare and must usually contribute to the support of workers and others whose means of livelihood are suspended or destroyed by these upheavals. Also they have in most cases provided by means of protective tariffs for the maintenance of prices for the corporation's products higher than the free working of economic laws would permit. The public is thus, in a vital sense, a partner in interest in much of what the corporation does or does not do and we must face the fact that this interest will be increasingly insisted upon unless the industries themselves overcome in a fair and equitable manner the difficulties that now confront them. In accomplishing this means must be found for the coöperation of employer and employee.

The best minds seem to be agreed that this cannot be done by force or suppression, but must be done by intelligent and broad-minded study of what industrial conditions really are and how to improve them; especially how to secure and maintain a spirit of coöperation and of enthusiasm in work, without which no great thing can be accomplished.

As our modern industrial life develops it becomes more and more clear that the broader interests of all of us, whether humble employee or mighty head of an industrial organization, are interwoven and inseparable. Formerly it seemed clear that the public was interested in industrial strife only where public service functions might be disturbed or suspended; but events have made it clear that, from the standpoint of public health, public education, service to the country in time of war or other emergencies, and of the general well-being of society, present and future, industrial strife concerns everybody; and there is a growing public sentiment according to which any industrial executive who refuses to confer with his employees, with their freely chosen representative, or with the representatives of any group of them, about the condi-

tions of employment, is assuming more responsibility than can safely be left to him. And we may be sure that it will in the end be much better for all of us to respect that public sentiment voluntarily. If we do not, then we must consider the possibility, if not the probability, that legislation as an expression of this public sentiment may follow.

Such a conference, properly and fairly conducted, will at least enable each side to know just where the other stands and why. Often this is sufficient to point out a clear way to a satisfactory adjustment. And a conference about business matters of mutual interest is not the handing over of one's business to employees or their representatives. Even if no concessions are or can be made, such a conference is almost sure to promote mutual understanding and good feeling; and I speak from personal knowledge and experience when I say that it may and often has prevented what might have been serious disturbances.

Such conferences however, in order to be effective for good, must be as friendly and courteous as other ordinary business conferences between men whose duty it is to coöperate for a common purpose and for mutual advantage; men who, in other words, desire to, or must, maintain a decent friendly relation, not an antagonistic or a patriarchal relation.

If it be understood that any matter which any employee, or any group of employees, wishes to have adjusted can be brought to the attention of the management, either by an individual, by a committee of employees freely chosen by the men for that purpose, or by any other agency whatever that seems advisable to the workers themselves, acting freely and without coercion, and that such a matter will be regarded as a legitimate business affair and especially that no prejudice will arise against any member of such committee for having thus served his fellow-employees, very much misunderstanding will be avoided. If this plan is followed there will be no need for spies among the employees, spies being themselves not preventives of trouble and misunderstanding but promoters of them, often deliberately and intentionally so.

If the conditions of employment are fair and right, if there are few or no substantial reasons for dissatisfaction, if the channels of communication between owner and workers are kept free and open, agitators and trouble makers will seldom if ever make much headway.

Sometimes, however, under present conditions, a strike may be unavoidable. When it takes place if the management will make it plain to the men that they are not blamed for having the ambition to improve their condition; if there are no bitter denunciations; if there are no newspaper interviews condemning the men as being mentally incompetent or intentionally unfair and unreasonable; if it is regarded simply as a human error, or as a fever which will soon pass away; and that when it does, such of the strikers as have been decent and orderly and can be reemployed will be welcomed back, singly or in groups; if foremen and superintendents who have known the men they now find acting as pickets and have been in the habit of greeting in friendliness, will continue to do so; a satisfactory settlement will be much more easily, more quickly, and more surely reached than by the usual plan of recrimination and bitter denunciation.

This more advanced attitude must not be assumed for the purpose, however, but must be the reflection of a genuine feeling of sympathy and of tolerance. It is human nature for a man to be much more influenced by the opinion and advice of one who is friendly and sympathetic than of one who is contemptuous, harsh, or filled with hatred.

In commending this plan of procedure, which I realize may seem to many employers impracticable or impossible, I speak, nevertheless, upon the basis of experience, not only of my own, but of that of others, in large as well as smaller organizations, and it is not advanced as being in the interest of employees only, but of employers as well.

Foremen Trained for Leadership

Particularly do foremen usually need to be trained, or educated, if you please, to know how to treat men in order to get their enthusiastic coöperation and their best efforts. The foreman being ordinarily the only man representing an employer with whom the worker comes into contact, the "local color," so to speak, of the shop, as seen by the worker is given by the foreman, and many an employer suffers, in reputation and in pocket, by reason of a foreman who may be obsequious and ingratiating in the employer's office, but brutal and inconsiderate in the shop. Cases are on record, for instance, in which the good intentions of an employer in providing rest rooms for women employees were, unknown to the employer, set at naught by a foreman who cared nothing for rest rooms, but believed in driving women so long as they could stand at their machines.

Too little attention has been given to this and foremen need to be trained for leadership and led to understand that most workmen, if properly handled, are as ambitious to "make good" as they are themselves, and that by sympathetic leadership and teaching where needed, excellent workmen can often be developed from what at first may seem like very unpromising material. This is not mere theory or idealism, but is based upon wide observation and a very considerable personal experience in establishments run upon all sort of plans, from very good to very bad.

Difficulties with men are often due to causes that are obscure. A group of workmen who resisted a perfectly fair and mutually advantageous proposition pertaining to their work, were not understood until it was finally discovered that a thoughtless and ruthless "comptroller" recently placed in power, had, merely for his own convenience, arbitrarily made a change in their pay day which had seriously inconvenienced them. He had no more thought of consulting them about it or consulting the superintendent under whom they worked, than as though they were so many soldiers, compelled to obey without question any regulations made concerning them. By this they were for the time being convinced that the company cared nothing for their interests and, reciprocally, they cared nothing for the company's interests and were suspicious of any proposition made to them.

I am not, of course, to be understood as saying that they were right in that, but we are dealing with human nature and must take men as they are and make the best of them. Workmen are, after all, about the same as other people, will respond to given treatment in about the same way, and act about the same under given conditions. When we fully realize this we shall be on the right road to an understanding of them and of how to get along with them.

Successful industrial management has been declared to be, more than anything else, a "state of mind." The various systems we are now hearing so much about vary greatly in their capacity to help in arriving at good conditions, but under the best of them there must be a foundation consisting of a determination to be fair, considerate and entirely candid and aboveboard, or they will be of little use.

If I seem to stress unduly the duties and responsibilities of engineers and employers in these troublous times, it is of course not because I believe the workers to be faultless, but in the daily and in the trade press their shortcomings have been abundantly set forth and the present pressing problem is as to what the engineer and the employer may and ought to do to bring about a better understanding. That can be done, but not by dwelling upon old grievances or by calling hard names. There must be mutual forbearance, mutual understanding, and a general recognition of the fact that men who are to be of any use to society or to the industries must have their personal ambitions, and in order to have them must see some chance of attaining them.

We are hearing constantly more about service as constituting the only just claim to rewards. Certainly the engineer need not fear comparison with others on that score. Yet there are those who, with the best intentions I am sure, charge a large share of our industrial and social difficulties to features of modern industry that have been created and are maintained by the work of the engineer.

Especially do they charge that doing things by machinery instead of by hand, and the multiplication of large manufacturing establishments in which the work is minutely divided, have had a bad effect—have, indeed, made men and women slaves of the machine.

I think we may claim that there is a misapprehension about this and that machinery and large industrial establishments do not nor can they by themselves enslave or oppress human beings.

It is easily demonstrated by reason and by human experience that division of labor, machinery for increasing man's productive capacity and the use of capital in production all tend, by themselves considered, to help the worker—to release him from burdensome tasks and from the necessity for working too hard or too many hours per day for too little money.

Two Kinds of Monopoly

But certain monopolies may and do have the opposite and injurious effects referred to; especially monopoly of the earth's resources and the holding of such resources idle and beyond the reach of labor and capital that might otherwise be applied to them for the satisfaction of the wants of mankind.

And our tax system acts as though it were especially designed to promote this result, to discourage industry of all kinds and to encourage the holding idle of the earth's resources for higher prices to be brought about by pressure of population and the enterprise and labor of others.

Many a manufacturer has been hampered in making enlargements of his plant by the high prices of vacant and idle land needed for that purpose; said high prices having been actually created by the activities of himself and his employees and in no degree by those who had been holding the land idle.

Fourteen years ago our Society held its Spring Meeting in Chattanooga and visited a water-power development in the Tennessee River, near there. At that time the large dam was about half-finished and I was told by a prominent member of this Society, himself a manufacturer, that already in anticipation of the coming cheap power, the owners of factory sites on which it might be utilized had doubled or trebled the prices at which they were holding them.

We hear much of the blessings to humanity of the cheap water power that may be developed in large quantities from our streams. As a matter of fact, it will be found that in nearly every case where water-power rates are substantially less than the cost of steam power, the total cost of the water power is nevertheless about the same as for steam; for the owner of available land on which to build factories and who, as such, has rendered no service of any kind either in producing power or in any other way, pockets the difference in prime cost—not the engineer, the manufacturer, nor the consumer of the goods produced.

Moreover, while as a general thing the manufacturer whose efforts and enterprise build up these values is taxed heavily for doing it, the vacant-land owner escapes with nominal taxation on the ground that his property is non-productive, if you please.

I mention these things, not because it is the engineer's special province to deal with them, but it is at least as much his business as that of any other citizen and it has a direct and vital effect upon his work and his opportunities for employment, or for going into business.

If it is the engineer's business to render service, then it is equally his duty to see to it that so far as possible all others do the same, and he has only to look about him to see that very many do not render service, yet are "clothed in purple and fine linen." The cure is not to take away their purple and fine linen, but simply to see to it that their having it is not by reason of their being able to restrict the opportunities of others for access to Nature's storehouse of raw materials and to work for the general welfare.

It is to be hoped that the day will soon come when every able-bodied and able-minded man will find it necessary to render actual service for what he receives and in fair proportion to what he receives. When that has been accomplished we need not concern ourselves overmuch about the way in which he spends his money. It will be clearly and of right his money, and the opportunities for spending it in such a way as to injure society will be much less than now.

That engineers are giving much more thought to these matters than formerly and are perceiving their important bearing upon the work and life of the engineer and all workers, is indicated by the fact that the President of the American Institute of Electrical Engineers, in his presidential address last year, discussed them, and the President of the American Society of Civil Engineers, the well-known Chief of the Reclamation Service, in his presidential address also discussed them; and we three, at least, are in agreement concerning them and their commanding importance, particularly in their effect upon the work of the engineer in whatever field of endeavor he may be engaged.

Of course an engineer or a manufacturer may be also the possessor of special privilege or a monopoly of one kind or another; but comparatively few of them really are, and where an engineer has acquired enough property to be called even moderately well off in these days of colossal fortunes, it will be found that his success in this is based upon the value of service which he has contributed to the general welfare, and those who envy such a man or who would limit his activities or his prosperity are very few and have practically no effective influence.

We can think of some engineers who have acquired what, until recently at least, would have been considered wealth. But they have usually done this in strictly competitive lines of business, engaged in by others, and open to all comers upon equal terms.

Compare the case of Corliss, for instance, and his early practice of selling his new improved engine upon the basis of a stated share of the saving in fuel for a limited time, with those usually absentee owners of the anthracite coal fields of Pennsylvania who create no coal, dig nor transport any coal, do nothing about coal except to own the ground in which it was placed by Nature long ages ago, "for the benefit of mankind," as we are fond of saying. Some of these owners are reported to have been recently doubling and more than doubling the royalties they collect for the mere privilege of employing engineers and miners and using machinery in the production of coal; the state of Pennsylvania helping them to retain their grip upon the coal supply by taxing their as yet unused coal lands at ridiculously low valuations as "unproductive farm lands," if you please; while real farmers in that state are taxed heavily not only upon their lands but upon everything else that can be found in their possession.

Herein is the backbone of the anthracite monopoly which is a grievous burden upon industries and upon coal users, and obstructs not only the production of coal but of all manufactured things in the production of which coal is a prime necessity. Being a citizen and a taxpayer in the state of Pennsylvania gives me the right, if nothing else does, to criticise its unenlightened and grossly unjust taxing system.

There are those, however, who will say that Corliss made his money by the possession of a monopoly, because his engine improvements were patented. But engineers especially need to clearly perceive the vital difference between such a monopoly as Corliss enjoyed and those monopolies of the earth's resources to which I have referred. Corliss had, for a limited time only, a monopoly of that which he had himself created, and any one who chose to do so went on using the plain slide-valve engine after the Corliss appeared, and all surely would have done so had not the terms offered by Corliss for the use of his improved engine been advantageous for the purchaser as well as for Corliss. In other words, the benefits arising from the improvements of Corliss were shared, first, by the purchaser of the engine, then by users of power, and finally by everybody.

Nearly always the same is true of any invention. It will not come into use unless purchasers of it share the benefits of what, before the invention, did not exist. Have we equal freedom of choice in the matter of fuel, not invented by man but created by Nature and an indispensable necessity of modern civilized existence?

Some thirty years ago a member of this Society invented a steam-engine governor from which he received a fortune in royalties based upon a certain charge per horsepower of engines to which it was applied. It is safe to say that that governor was never applied to one engine without benefiting both the engine builder and its purchaser by an amount far exceeding what was paid for its use. We are playing directly into the hands of those who advocate the socialization of all property and of all human activities when we for one moment admit that the inventor of any such thing is to be classed with those who monopolize that which is the common heritage of all of us—that which no man created and without which human existence cannot be maintained.

It would of course be wrong to condemn individuals who simply take advantage of a system that has long been tolerated by their

(*Continued on page 8*)

Power Applications to Cotton-Finishing Plants

By LEO LOEB,[1] PHILADELPHIA, PA.

The following paper presents an analysis of the power applications to cotton-finishing plants in which, under ordinary conditions, the steam required for processing is greater than that for power development. The generation of power and of steam and the applications to the driving of process machinery are traced briefly from the boilers to the motor applications. Charts are presented showing the steam consumption and the proportion of the exhaust steam converted into work and available at the exhaust for different types of prime movers. Illustrations of typical drives are included.

In the finishing processes in the textile industry, such as bleaching dyeing, mercerizing, printing, calendering, etc., the quantity of steam required for processing and for the heating of manufacturing space may be from two to four times that required for power.

Opinion as to the lowest working steam pressure for process work consistent with steady output and a minimum production of "seconds," is almost as varied as the number of plants. It has been found, however, that with ample heat transfer surface, pressures of from 10 to 15 lb. gage, with an average of 12 lb., will take care of fully 80 per cent of the requirements in finishing.

It follows, therefore, that all power may be generated as a by-product by utilizing engines or turbines as reducing valves. Steam at boiler pressure is thus reduced to the low pressure of the exhaust line without thermal loss other than the heat converted into work and, in case of reciprocating engines, the loss in cylinder condensation.

From the economic standpoint power cost will be merely the fuel equivalent of conversion and condensation, labor and material costs in attendance upon and maintenance of equipment, and fixed charges on power-plant machinery. Under these circumstances purchased power can seldom compete with self-generation, provided the installation be large enough to keep the overheads and operating labor costs to a low figure per kilowatt-hour of output.

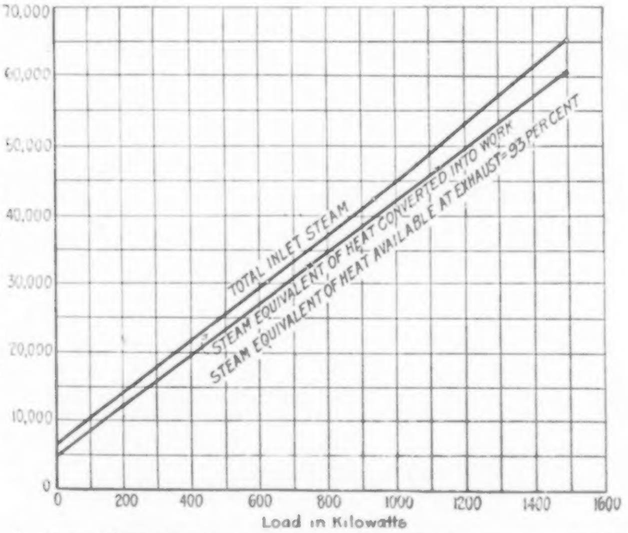

Fig. 1 Steam Consumption and Available Exhaust from a 1500-kw. Non-Condensing Turbo-Generator

Steam pressure at throttle, 175 lb. per sq. in.; back pressure at exhaust, 12 lb per sq. in.; steam flow at full load per hour, 65,000 lb.; equivalent steam available at exhaust, per hour, 60,600 lb.; inlet steam available at exhaust, 93 per cent.

Boilers

For obvious reasons water-tube boilers are coming into more general use in the boiler houses of finishing plants. The same points of superiority over horizontal or vertical fire-tube boilers which manifest themselves in central station use apply in the selection of boilers for a finishing plant. The working steam pressure should range from 150 to 200 lb., the higher figure being preferable where its use does not add unduly to the first cost of boilers. A moderate degree of superheat is desirable, although not essential. Superheat reduces condensation in steam lines and results in somewhat better economy of engines or turbines, but there may be objections on account of the superheaters and their maintenance.

Among the items of minor equipment which are becoming increasingly popular may be mentioned soot blowers and reliable feedwater regulators.

Fuel and Firing Devices

The kind of fuel used is intimately associated with its method of burning. The use of steam sizes of anthracite, except where mixed with bituminous coal, is not increasing. The market is restricted, and few types of stokers for this fuel have been developed. High boiler ratings easily reached with bituminous coal cannot be duplicated with anthracite; hence the installed boiler capacity and the first cost of boiler plant must be greater than with soft coal. Increasing fuel costs, higher freight rates and labor advance all work under normal market conditions toward the reduction in consumption of the lower grades of anthracite, particularly at points remote from the coal fields.

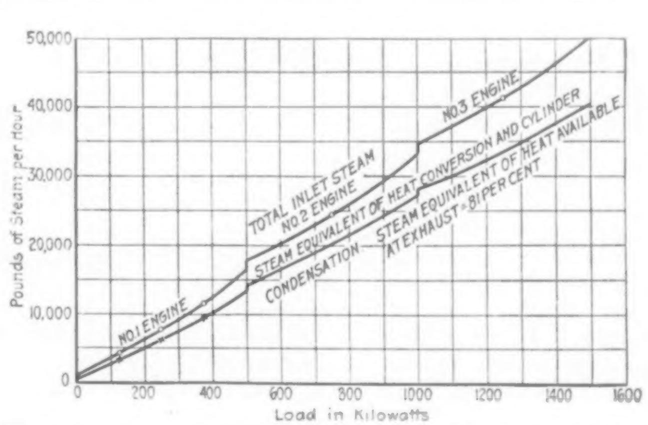

Fig. 2 Steam Consumption and Available Exhaust from Three 500-kw. Non-Condensing Engine Generators

Steam pressure at throttle; 175 lb. per sq. in.; back pressure at exhaust, 12 lb. per sq in.; steam flow at full load, per hour, 50,000 lb.; equivalent steam available at exhaust per hour, 40,600 lb.; inlet steam available at exhaust, 81 per cent.

As in all other industries, bituminous coal leads in the proportion of fuel utilized by finishing plants. The newer installations for soft coal have underfeed stokers, of which there are now several reliable types on the market. Where the cost of large brick or steel chimneys is prohibitive, induced-draft fans may be installed, and this apparatus is always provided with economizer installations.

Fuel oil is the ideal fuel, but high price and possibility of shortage during times of emergency have combined to restrict its use. There are many advantages and economies in its use, and very recently there has been evidence that the large oil producers are entering the field to secure new business. Quick steaming, cleanliness and reduction in labor are the foremost economies, but no large plant should go to oil fuel without providing means for quickly converting a portion of its capacity to coal burning in case of acute and prolonged shortage of oil.

The use of powdered coal as a boiler fuel is just beginning to emerge from the experimental stage. Under favorable conditions the efficiency of combustion will be high, but offsetting this are such points as: liability to dust explosion; cost of drying and

[1] M. E., Day Zimmermann, Inc., Jun. Mem.Am.Soc.M.E.

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grinding; nuisance from fine ash which will be deposited on adjacent property; and high brickwork and refractory maintenance.

Prime Movers

The selection of primary drive is a matter which will depend to an extent on the size of the plant and the schedule of operation. In certain districts water power is still available during a considerable portion of the year, and this power is usually utilized by the mills as a part of privileges and grants dating back to the original acquisition of the mill property.

The water-power companies will likewise sell surplus water power under contract conditions, but the charges for such excess power will likely be in excess of rates for purchased power. This is due principally to the fact that individual mills have small wheels of low efficiency, and the power company, where itself engaged in the hydroelectric business, can develop a horsepower hour through its larger and more efficient machinery on less water than the individual mill. Likewise conditions of load factor and diversity, together with control of storage water, generally put the power company in a more favorable position to utilize the water than to sell it.

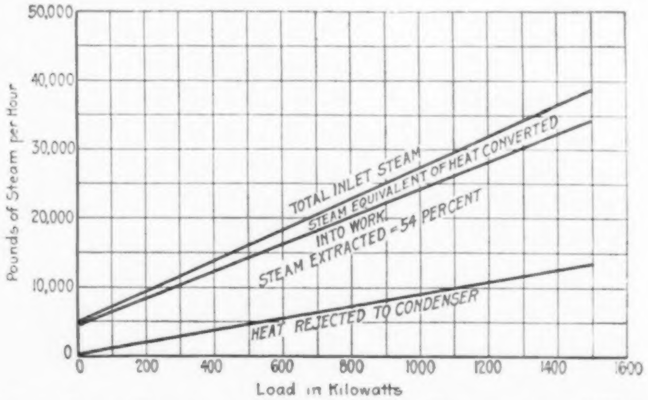

Fig. 3 Steam Consumption and Available Exhaust from 1500-kw. Extraction Turbo-Generator

Steam pressure at throttle, 175 lb. per sq. in.; extraction pressure, 12 lb. per sq. in.; vacuum in condenser, 28 in.; steam flow at full load, per hour, 39,000 lb.; steam extracted at full load, per hour, 27,000 lb.; inlet steam extracted, 69 per cent.

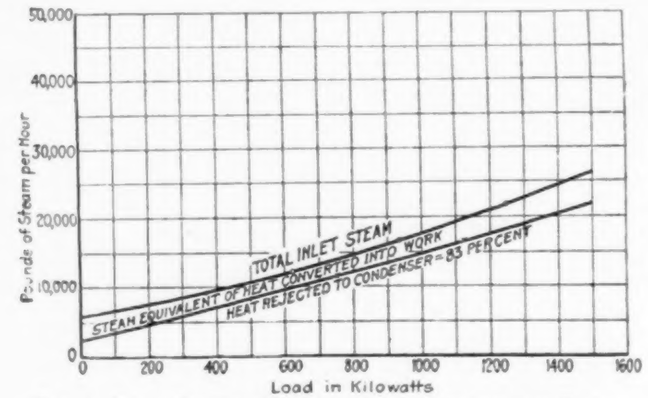

Fig. 4 Steam Consumption of a 1500-kw. Condensing Turbo-Generator

Steam pressure at throttle, 175 lb. per sq. in.; vacuum at exhaust, 28 in.; steam flow at full load per hour, 26,400 lb.; inlet steam rejected in circulating water, 83 per cent.

Where water-power privileges have been acquired in terms of horsepower without time limit as to use, the individual mill can generally afford to continue any existing development up to its original privileges, particularly if some departments requiring power in excess of process steam are likely at times to operate when the rest of the plant is idle. Water-power privileges form a convenient means of developing power for night lighting and for the overtime operation of mechanical departments.

Naturally the available water power is subject to considerable seasonable variation, and a plant desiring continuity of operation must of necessity have sufficient steam-power stand-by to take care of its requirements under low-water conditions. The chances for duplication in investment are therefore obvious, so that the development of power from water should in every case be subject to careful analysis.

Steam power in the smaller mills may be developed in economical engines, but for plants requiring any considerable amounts of power the turbine drive from all points of view is preferable. Any steam engine, no matter how efficient, is subject to cylinder condensation, which represents a dead loss, whereas a turbine will extract from the steam only such energy as is converted into work, retaining the remainder of the latent and sensible heat in the exhaust steam.

This point is worth emphasizing, because it may happen that a certain type of steam engine has an actual water rate per unit of output lower than the same size of turbine. However, the net heat available for processing will always be greater with the turbine.

There is a field of application for the bleeder type of turbine in which steam may be extracted from an intermediate stage for processing or for building-heating requirements. The excess steam to make up power demand passes to a condenser. The latent heat in this condensed steam may in part be recovered by utilizing circulating water for processing and for make-up boiler feedwater. There will, however, be at all times an unavoidable loss of heat rejected at condenser outlet.

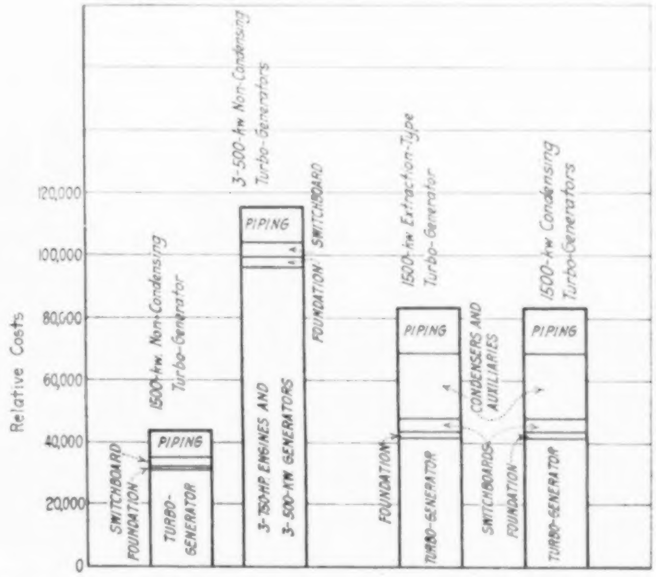

Fig. 5 Relative Installation Costs of Four Different Types of Prime Movers

Figs. 1 to 4 show for prime movers of four different types the relative steam consumption per unit of output and the relative heat consumption under conditions where exhaust steam can be fully utilized at all seasons of the year. Assuming in each case that the primary drive is connected to an electric generator, the relative costs, based on a 1500-kw. size, will be approximately as shown in Fig. 5.

Electric Drive

Except in smaller mills where belt drive may be used in connection with a steam engine, the tendency is now entirely toward electrification, both by groups and by individual machines.

The electrical characteristics of generators and motors must be determined after a study of the local requirements for variable speed as against constant-speed drives. In certain instances the selection will be influenced by the amount of electrical equipment already installed in the mill and the power characteristics of the local public utility on whom it may be desired to depend for stand-by service.

The three main subdivisions of power applications to finishing plants are:

a Such power as is required to drive groups of machines or individual process machinery at constant speed. This applies to bleaching, washing, short tentering, damping, jig dyeing, pasting; also to ventilation, color mixing and pumping.

b Such power as is required to drive process machinery with moderate speed variation not in excess of 2 to 1 to accommodate variation in fabric and process. This includes certain forms of mangles and cans, sheet ranges, starch mangles, mercerizers, khaki, sulphur and indigo dyeing machines and steamers.

c Such power as is required to drive process machinery where the demands for variation in speed are in excess of 2 to 1. This class of equipment includes long tenters, aging boxes and multi-color printing machines.

For variations in speed in excess of 2 to 1, the direct-current motor occupies the leading position, unless it be desired to resort to some form of mechanical speed-changing device.

In the class of finishing plants considered, the operations of tentering and printing will frequently require speed ratios outside the range of commercial forms of alternating-current motors. Hence the proportion of power consumed by motors driving tenters and printing machines to the entire mill requirements, is an important factor in deciding whether the entire electrification shall be direct current, or whether a combination of alternating and direct current be applied. A suitable direct-current voltage is from 230 to 250 volts.

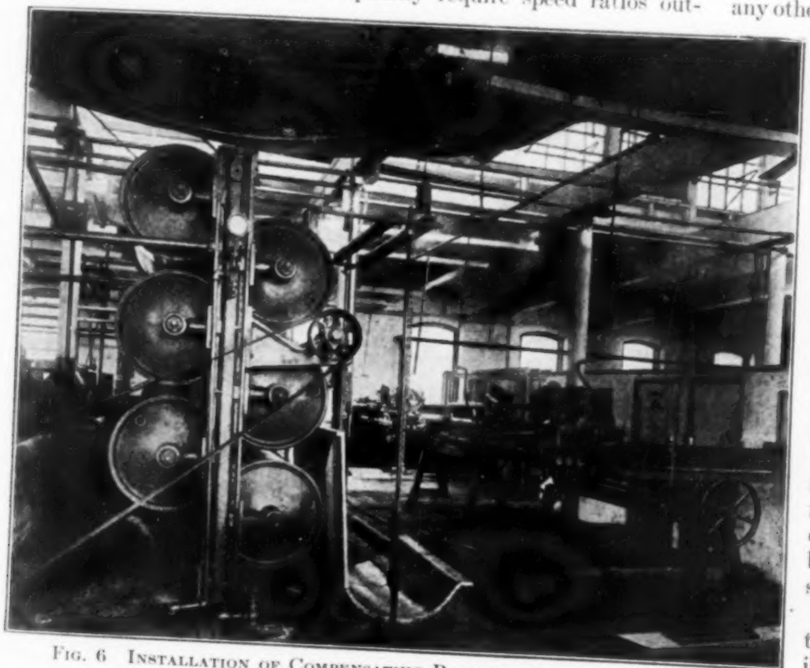

Fig. 6 Installation of Compensating Roll for Synchronizing Two Variable-Speed D.C. Motors

In the larger mill projects the electrical characteristics of generators are generally 3-phase, 60-cycle, with voltages varying according to the choice of the designer and his method of solving the power problem.

The voltages in use are 220, 440, 550 and 2200, the two intermediates being the most popular. The lowest voltage calls for large sizes of conductors and conduits, and the highest cannot be used directly on all mill motors, hence transformers for stepping down to motor voltage must be installed. In such a development direct current may be obtained from rotary converters or motor-generator sets. Although the rotary converter has a higher efficiency and may occupy less floor space than the motor-generator set, the use of the latter is preferable because of its ability in effecting power-factor correction.

Modern alternating-current generators are designed on a basis of maximum current output, hence in such finishing plants as have a large proportion of inductive motor load it may be well to specify a load power factor of 70 per cent or 75 per cent when selecting generators, rather than the more usual 80 per cent used in central-station practice.

There are two methods of providing power for night lighting and the overtime operation of mechanical departments. One is the installation of a small turbo-generator of sufficient capacity to take care of lighting and shop load. This machine will have exactly the same electrical characteristics as the main units, but will have a lower water rate for the off-peak load.

Another method successfully applied is to provide some excess capacity in the steam exciter and by means of a selector switch transfer the lighting load from the normal supply of three-wire 100-volt alternating current to two-wire 110-volt direct current. Likewise the shops may be equipped with a 110-volt direct-current motor taking its power from the turbo-exciter and driving the shops when the manufacturing departments are idle.

Where the size of the equipment justifies the expense, generator coolers should be installed in connection with high-speed alternating-current turbo-generators. These generator air washers not only permit of high capacity of the generators during extremely warm weather, but likewise remove coal and ash dust, lint and any other foreign matter whose presence might damage the generator windings.

Motor Application

Constant-speed groups or individual drives are best operated by induction motors controlled by motor-starting switches convenient to the operator and protected against injury by overload and low-voltage trips.

For constant-speed drives having heavy starting duty it may be necessary to use slip-ring motors with drum controllers and with resistances in the controller circuit for starting duty only. A safety or oil switch should be provided in the primary circuit.

Another group of drives falls in the class where the requirements of the process are met by a speed reduction of two to one, or where the lowest speed needed at any time will be 50 per cent of the maximum speed. It is not always necessary under these conditions to resort to the direct-current motor, since a slip-ring motor with secondary resistance banks designed for continuous running at any point of the controller has been found suitable for mangles, cans, open tenters and sheet ranges.

The control equipment consists of a drum controller and resistance for the secondary circuit. The incoming feeder should be protected by an oil switch with overload and low-voltage releases.

It should be borne in mind in applying slip-ring motors for variable speed that, except for the limitation of maximum speed imposed by the frequency of the alternating current, a slip-ring motor has speed and electrical characteristics very similar to the series type of direct-current motor. Consequently variations in load arising from such adjustments as the set on rolls or the friction of cloth over cans and rollers will produce variations in speed without any change of controller position.

The applications of variable speed with higher ratios by means of direct-current motors opens up a wide field in the selection of control equipments. Various manufacturers have developed outfits to suit local conditions and the ideas of the designer. These controls vary all the way from the simple faceplate rheostat for varying the field strength of a shunt-wound direct-current motor to the more elaborate push-button control contactor panels.

A form of safety device which should never be omitted is some form of push-button or snap-switch release whereby the back tender on printing machines or tenters may from his position instantly shut down the entire equipment.

It is usually convenient to use two motors for driving long tenters, one driving the tenter equipment proper and the other operating the mangle and cans. In order to preserve proper synchronism between the two motors, a compensating equipment such as is illustrated in Fig. 6 may be applied.

Since in the raw materials utilized in finishing plants steam and power rank second only to gray goods and drugs, the necessity for measuring the power and steam consumption of all departments

is obvious. This can be accomplished by the simple application of integrating wattmeters to power feeders and of flow meters to steam lines. The number of electric and steam meters need not be excessive and their cost will soon be returned in the form of better knowledge on the part of the executive as to plant conditions, and in the ability to locate immediately and check wastes and losses. An actual steam distribution is shown in Fig. 7 for both the heating and non-heating seasons.

In some cases there may be a tendency toward thermal unbalance occurring during periods of low production in the non-heating season, or during periods of the working day when the power load is building up more rapidly than the process steam consumption. Any loss of this kind may be checked readily by the installation of a storage heater, in which the heat-transfer surface is proportioned in accordance with the rate of discharge of exhaust steam, and the volumetric or storage capacity in accordance with the duration of the period of unbalance and the

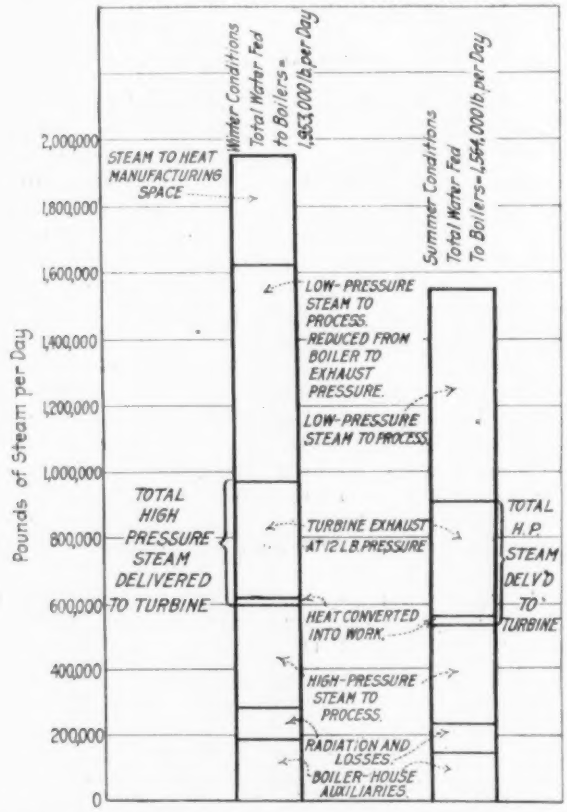

Fig. 7 Steam Distribution (Heating and Non-Heating Seasons) for Finishing Plant with Correct Heat Balance

X: Total high-pressure steam delivered to turbine.

heat to be absorbed in that period. This hot water can be drawn upon for washing or for whatever purpose hot water is required in the process.

A general plan of power application based on a complete heat balance such as has been described in this paper will lead to very substantial economies in fuel, labor and maintenance costs in the power department over the more general use of engines for group or individual drive. Particularly at this time, because of advancing freight rates, scarcity of fuel, high prices prevailing and unsatisfactory transportation conditions, have fuel costs and power economies assumed national significance. Indeed, the Government has recognized the prime importance of this problem in its relation to the conservation of natural resources through the superpower survey being conducted by the Department of Interior.

THE ENGINEER'S SERVICE TO SOCIETY

(Continued from page 4)

fellow-citizens, and is generally looked upon as respectable and proper. It is not individuals but the system that is wrong, and wrong because it permits and even entices men to take steps to secure large rewards without doing anything of real value in return for them; particularly to make themselves a heavy burden upon the industries which the engineer is trying to develop and upon which he depends for his opportunities to render service.

All clear thinkers, I believe, support and will maintain the just rights of property; but it is becoming clearer every day that a necessary condition for safe-guarding property rights is, first and above all, the safe-guarding of human rights. In fact, security of property rights rests, finally, upon the maintenance of human rights.

It is not true that "the world owes every man a living," but the world does owe every man an exactly equal opportunity to earn a living.

And let us not be deceived by the newly invented factor of production called "ability," which, it is asserted, rests somehow upon an economic basis different from that of labor. Labor, in the broad sense—the economic sense—is any kind of useful endeavor, mental or manual. There are only three factors in production of wealth: land or Nature's resources; labor, mental or physical; and capital. The invention of so-called "ability" as a fourth factor has no basis in reason or experience and its only function is to confuse our reasoning about industrial and economic problems and to bring us to erroneous conclusions concerning them. Especially has it been invoked in attempts to justify exorbitant gains by those who rendered no service in return and were often mere gamblers. A burglar or a pickpocket may exercise ability in his profession, and even the right kind of ability is of no use unless exercised, and then it is labor.

If it is true that any considerable portion of our American workers are being led astray by ultra-radical teachings, then such teachings may be most effectively combated by such teaching as the engineer is in a position to give. But it will not answer to simply assert that there is nothing the matter and that we should all be content with things as they are, or as they were in a time now past and gone. There must be, in such teaching, evidence of a real understanding of what conditions really are and of a sympathetic attitude toward any reasonable and fair ambition to improve them.

It must be shown, as it easily can be, that profits, in normal times and in competitive lines of business and manufacturing, are usually and on the average not greater than they need to be to attract to them capital and men capable of carrying them on; and that business men and manufacturers as well as workers, often suffer from the power of special privilege and inadequately regulated monopolies.

The fact is that our economic and social science has not kept pace with the work of the engineer; for he, in his own work, is by temperament and training an innovator. He lives to persuade other people to do new things, or to do old things in entirely new ways. This being so, it would seem to be logical that he himself should at least maintain a sufficiently open mind to avoid resisting a new thing concerning which he has not cared to, or has had no opportunity to, investigate.

Whether it be a new idea in industrial management; revision of our tax system so as to remove burdens from beneficial activities and to discourage monopolies; a League of Nations to preserve the peace of the world, so that the results of the work of the world can be wholly useful instead of largely wasteful, destructive and pernicious; we engineers, especially, ought not to remain bound by mere custom, which, as Guizot said:

"....contracts our ideas with the circle it has traced for us; it governs by the terror it inspires for any new and untried condition; it makes us believe the walls of the prison within which we are inclosed to be the boundary of the world, and beyond all is undefined, confusion, chaos, where, it makes us feel, we should not have air to breathe."

Customs and usages have their places and their values, but when new problems present themselves we must not shrink from the contemplation of what are, or may seem to be, new remedies, so long as they are founded upon established principles of justice and fair dealing.

Side-Cutting of Thread-Milling Hobs

By EARLE BUCKINGHAM,[1] NEW YORK, N. Y.

It has long been known that the side-cutting action of a hob distorts the form of the thread on the work, or in other words, the form of the tooth on the hob is not reproduced on the threaded part. The present paper is the result of a mathematical investigation of this subject and points out the corrections in the form of thread-milling hobs which can be readily made and also produce threads sufficiently correct as to form for all practical purposes. The profile of the thread cut with a hob is a combination of two distinct curves. First, a small fillet is formed at the root of the thread which is the path of the outside corner of the hob. No correction in the form of the hob is possible to correct this point. Second, the larger part of the flank of the thread consists of a slightly curved profile which is formed by the overlapping paths of the infinite number of cutting points which form the cutting edge of the hob. Mathematically, a curved correction can be applied to the form of the hob which will correct this profile entirely. Practically, a straight-line correction can be applied which is almost exact, as the amount of the actual curvature on the flanks of the thread is seldom greater than one-tenth of a thousandth part of one inch. The greater the angle of helix of the thread, the greater the amount of correction necessary. The complete paper deals with both externally and internally threaded parts, but in the present abstract only externally threaded parts are considered. The general conditions of side-cutting are identical, however, in both cases.

When a thread is chased in a lathe and the cutting tool has proper clearance and is set so that the plane of the cutting edges contains the axis of the thread, the exact form of the tool will be duplicated on the work. Assuming that the thread is completed, if the tool in its cutting position is brought into contact with the flanks of the thread, it will have a line bearing only. If sufficient clearance can be provided on the tool, this holds true regardless of the pitch of the thread, the angle of the flanks, or its diameter.

When a thread is hobbed, however, the axis of the hob being parallel to the axis of the thread, the path of any one cutting point is a circle, and this circle will interfere with the helix of the thread to an amount depending upon the pitch of the thread, the angle of the flanks, and the diameters of both hob and thread.

It is assumed in this discussion that the cutting teeth of the hob are backed off sufficiently to prevent any dragging of the relieved portion of the tool on the work. The interference between the cutting edge of the hob and the helix of the thread therefore results in the removal of additional metal, thus distorting the form of the thread. The amount of this distortion varies as the values of any of the following factors change: the pitch of the thread, the form of the thread, the diameter of the work, and the diameter of the hob.

It will be shown that correction for some of this distortion inevitable with this method of manufacture is impossible. The amount of this distortion, however, can be reduced in many cases by the proper relation between the diameters of work and hob. It will also be shown that most of the distortion can be corrected by a suitable alteration in the form of the cutting tool.

The Hobbing of Screws

In Fig. 1, which shows a diagram of a hob and screws, let

- R = radius of any cutting point on the hob
- r = radius of deepest point on work touched by R
- N = number of threads per inch
- A = angle of rotation of hob
- B = angle of point of contact of R at angle A
- C = $^1/_2$ included angle of thread
- r' = radius of point of contact of R on work.

Formulas will first be derived to show the interference between the path of any cutting point on the hob and the flanks of the thread and for purposes of plotting the radial distance of the cutting point R from the deepest point on the work touched by R will be designated as y. In other words,

$$y = r' - r \qquad [1]$$

The longitudinal (or axial) distance R of the cutting point from the flank of the theoretical thread will be designated by x. A plus value of x will indicate a clearance, while a minus value will indicate an interference or side-cutting.

In order to determine the value of y the triangle shown in heavy lines in Fig. 1 must be solved. The known factors will be taken as r, R, and B. We first have

$$\frac{(R + r)\sin B}{R} = \sin 180° - (A + B)$$

$$\sin 180° - (A + B) = \sin (A + B)$$

$$\frac{(R + r)\sin B}{R} = \sin (A + B) \qquad [2]$$

From this equation we determine the value of A. Solving the triangle for r', we have

$$r' = \frac{R \sin A}{\sin B} \qquad [3]$$

and when the value of r' is determined, the value of y is established from Equation [1].

As the hob revolves away from the common center line of the

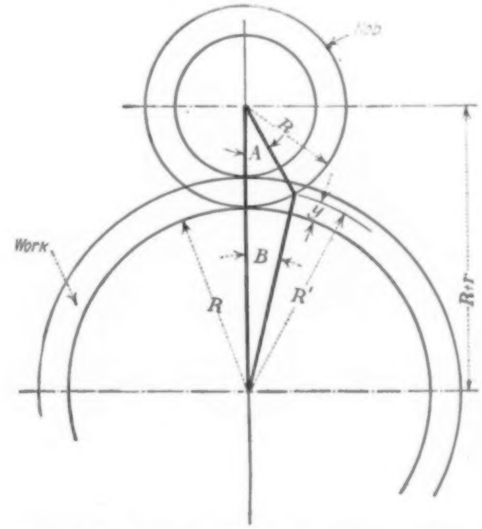

Fig. 1 Diagram of Hob and External Screw

hob and work, the cutting points on one side of the tooth of the hob, due to the helix of the thread, will have a clearance with the flank of the thread, while the cutting points on the other side of the tooth of the hob will develop an interference. But the side of the hob which clears the helix as the cutting point revolves away from the common center line will interfere as the cutting points approach to the common center line, and the nature and extent of this interference will be symmetrical and equal on both flanks of the thread as long as the form of the thread is symmetrical.

The amount of interference depends upon the value of B and the pitch of the thread, or number of threads per inch, N. Thus

$$\text{Interference Due to Helix} = \frac{B}{360N} \qquad [4]$$

If the included angle of the flanks of the thread is greater than zero (which is the case for all but square threads), as the cutting point of the side of the cutting tooth departs from the common center line of the hob and work a clearance develops between the cutting point on the hob and the flanks of the thread. The amount of this clearance depends upon the value of y and the included angle of the thread, and referring to Fig. 2 it will be seen

[1] Engr. of Standards, Niles-Bement-Pond Co., and Pratt & Whitney Co., Assoc.-Mem.Am.Soc.M.E.

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that its value, ignoring for the present the helix of the thread, may be expressed as:

$$\text{Clearance} = y \tan C \qquad [5]$$

The value of x is therefore found by subtracting the amount of interference given by Equation [4] from the amount of clearance given by Equation [5], or

$$x = y \tan C - \frac{B}{360N} \qquad [6]$$

As an example of the use of the above formulæ, we will assume that we wish to hob a thread which has a radius r or 0.5625 in. at the minor diameter with a hob whose radius R is 2.250 in. at its outside diameter with 4 threads per inch. A thread with a relatively large helix angle is taken as the first example in order to show the nature of the resulting side-cutting of a hob. The thread has an included angle of 60 deg., making C = 30 deg., and N = 4. The value of B is taken from 0 deg. to 12 deg., which gives the following values for x and y:

For B = 0°	2°	4°	6°	8°	10°	12°
x = 0	—0.00114	—0.00176	—0.00194	—0.00157	—0.00064	—0.00084
y = 0	0.00043	0.00176	0.00386	0.00691	0.01092	0.01589

The above as well as intermediate values are plotted in Fig. 3-A at the left, and the actual path of the cutting point is shown at the right. These curves show the general form of the side-cutting of any point on the cutting face of a thread hob.

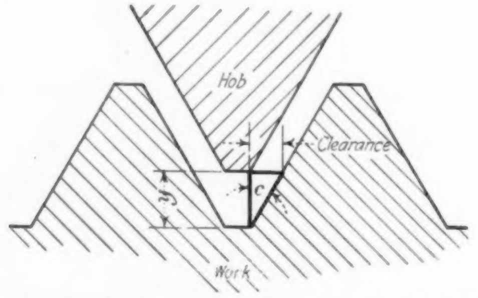

Fig. 2 Diagram Showing Clearance between Hob and Work

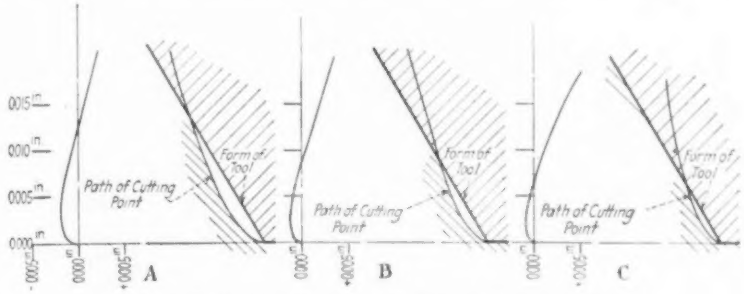

Fig. 3 Curves Showing Paths of Cutting Point

This cutting face of the hob is made up of an infinite number of points. As the positions of these points vary, the ratio between R and r varies, as also does the helix angle of the thread, and therefore each cutting point travels in a different form of path. Thus, in order to determine the resulting form of a thread cut with a hob it will be necessary to plot the paths of a few other points. A point 0.20 in. higher on the flank of the thread will therefore next be taken. This gives R = 2.050, and r = 0.7625, as before, C = 30 deg. and N = 4, and the values for x and y with these factors are as follows:

For B = 0°	1°	3°	5°	7°	9°
x = 0	—0.00061	—0.00126	—0.00117	—0.00032	—0.00136
y = 0	0.00015	0.00143	0.00398	0.00786	0.01318

These values are plotted at the left in Fig. 3-B. The actual path of the cutting point is shown at the right.

A third point 0.40 in. above the bottom of the thread will also be taken. This point is beyond the top of the thread, but it is taken to accentuate the distortion developed by hobbing. In this case R = 1.85, r = 0.9625, C = 30 deg., and N = 4. The values for x and y with these factors are as follows:

For B = 0°	1°	3°	5°	7°
x = 0	—0.00057	—0.00093	—0.00026	—0.00151
y = 0	0.00022	0.00199	0.00566	0.01104

The above values are plotted at the left in Fig. 3-C. The actual path of the cutting point is shown at the right.

In order to show more clearly the nature of the side-cutting of hobs, the curve in Fig. 4 is plotted in an exaggerated form with the intervals along the y-axis equal to 0.001 in., and those along the x-axis equal to 0.0001 in. The curves shown in Figs. 3-A, 3-B and 3-C are plotted to this scale and brought together proportionately; that is, the origins of these curves are spaced equally from the bottom, but these spaces are not to scale. This distorts still further the exact shape of the curve, but its general properties are correct.

This curve shows the general nature of the distortion in the form of a thread which is caused by the side-cutting of the hob. It will be noted that it is a double curve, the lower part (below the line A–A) being developed by the bottom corner of the hob tooth while the upper part (above the line A–A) is developed by the overlapping paths of successive cutting points on the cutting face of the hob. It is evident that the distortion shown at the bottom of the curve is inevitable and no correction in the form of the hob is possible that will eliminate it. It can be reduced in many cases, however, by making the hob smaller in diameter. On the other hand, the distortion shown in the upper part of the curve can be eliminated by changing the form of the cutting edge on the hob.

The correction of the hob is determined in the following manner: The greatest amount of side-cutting is done by the bottom corner of the hob. In the foregoing example the tabulation shows 0.00194 in. when B = 6 deg. This is not necessarily the exact maximum. If a closer value is required, the tabulations must be made with increments of B of smaller amounts. Tabulations as shown, however, will be correct to the fourth decimal place, which is sufficiently accurate for most purposes.

If the tooth of the hob is narrowed at each point of the cutting edge by the amount which it side-cuts the thread form, the contour of the thread above the line A–A in Fig. 4 will be correct and in most cases it will be found that the correction in a straight line will be sufficiently accurate as the resulting error will be negligible.

Fig. 5-A represents the form of a thread cut with a hob having the form of the cutting edges identical with the true form of the thread. In this figure,

C = half included angle of thread
F = width of flat of thread at the root or minor diam.
r_1 = largest value of r employed (radius of major diam.)
r_2 = smallest value of r employed (radius of minor diam.)
x_1 = maximum minus value of x for r_1
x_2 = maximum minus value of x for r_2
$(r_1 - r_2)$ = depth of thread
$2(r_1 - r_2) \tan C + F$ = width of space at major diameter (outside).

Fig. 5-B illustrates a corrected hob and the form of thread cut with it. In this figure,

$F - 2x_2$ = width of flat at bottom of hob form
$2(r_1 - r_2) \tan C + (F - 2x_1)$ = thickness of hob form at top
C' = half the included angle of corrected hob.

If the cutting edge of the hob is kept as a straight line, the tangent of half the included angle of the hob form will be equal to half the difference between the widths of hob form at the top and bottom divided by the height of the form. Using the values shown in Fig. 5-B, we have the following:

$$\tan C' = \frac{2(r_1 - r_2) \tan C + (F - 2x_1) - (F - 2x_2)}{2(r_1 - r_2)}$$

$$\tan C' = \tan C + \frac{F - 2x_1 - F + 2x_2}{2(r_1 - r_2)}$$

$$\tan C' = \tan C + \frac{x_2 - x_1}{r_1 - r_2} \qquad [7]$$

It will be seen from Equation [7] and also from the figures that a corrected hob will have a greater included angle than the thread

itself; or, in other words, the included angle of a hobbed thread on a screw or male-threaded part will be less than the included angle of the hob.

The dotted line in Fig. 5-B represents the true correction of the hob. Also in this figure,

r_3 = value of r at middle of thread flank (or at pitch diameter)

x_3 = maximum minus value of x for r_3

K = difference at r_3 between straight-line correction on hob and true correction

$$\frac{x_2 - x_1}{2} + x_1 = \frac{x_2 - x_1 + 2x_1}{2} = \frac{x_2 + x_1}{2} = \text{correction at } r_3 \text{ when hob form remains a straight line.}$$

$$K = \frac{x_1 + x_2 - x_3}{2} \qquad [8]$$

If the rounding or fillet at the bottom of the thread as shown in Fig. 5-B is objectionable, the point of the hob may be extended by an amount about equal to y_2, provided that such an undercut is permissible. By so doing an almost theoretically perfect thread form will be secured. Theoretically, the point should extend slightly more than y_2, as at this point r becomes smaller and R becomes larger than the values of r_1 and R_1. Referring to Equation [3], this increase in the value of R will increase the value of r'. Referring to Equation [1], this increase in the value of r' and the decrease in the value of r will increase the value of y. But for all practical purposes an extension on the point of the hob of the nearest even dimension to y_2 will usually be sufficiently accurate. On standard threads cut with hobs the resulting error will be in fifth or sixth decimal place.

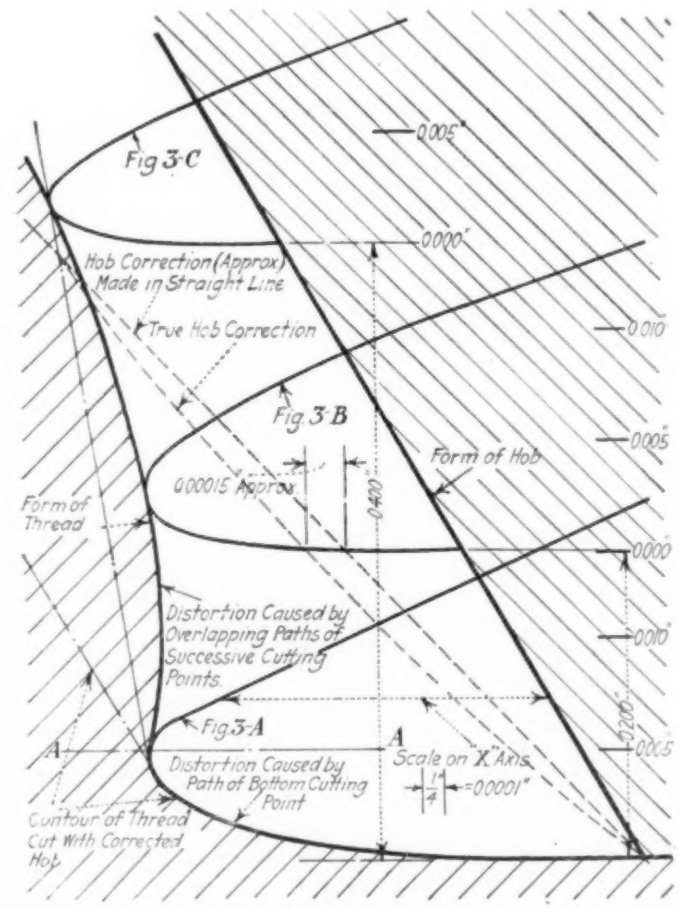

FIG. 4 CURVES SHOWING SHAPE OF CUTTING PATH

For the purpose of simplifying calculations tables have been developed which are given in the complete paper. These tables are based on work whose radius is 1.000. The value of $B/360$ is given opposite varying values of B and values of y/r are given for different values of r/R. In order to use the tables the value of r/R must first be determined, then the value of y/r is multiplied

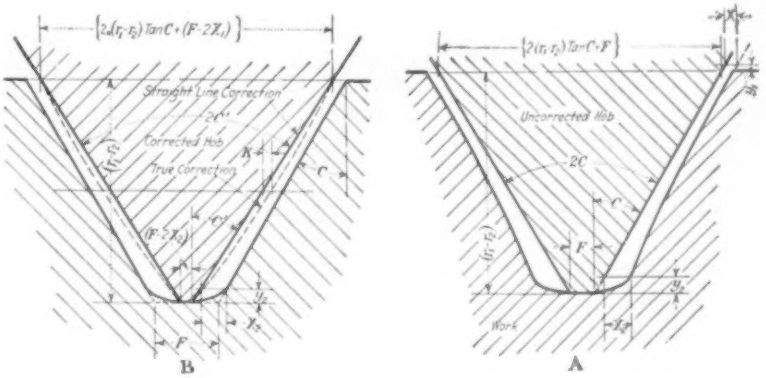

FIG. 5 FORM OF EXTERNAL THREAD CUT WITH UNCORRECTED AND CORRECTED HOB

by the radius of the work to obtain the value of y. The values of y/r may be obtained by interpolation when the value of r/R does not agree with any of those given. The values given under $B/360$ are divided by N and substituted in the equation $x = y \times \tan C - (B/360N)$ to obtain the value of x.

In order to illustrate the use of these tables and to determine the effect of varying the diameter of the hob, values are given in the complete paper for an Acme thread (5 threads per inch, one inch in outside diameter) cut with three hobs, the first one inch in diameter, the second two inches in diameter, and the third four inches in diameter. An Acme thread is selected because the smaller included angle of thread results in more side-cutting, thus making more pronounced the effect of varying the diameter of the hob. The depth of an Acme thread of this pitch is 0.110 in. The included angle is 29 deg. The width of the flat at the root of the thread is 0.0689 in.

The final value of the included angle, $2C'$, as given by Equation [7] is found to be 29° 59′ 26,″ and in the particular case chosen the difference between the angle of the hob and angle of the work is 59 min. 26 sec. The correction is therefore made in a straight line. By means of Equation [8] the difference K between this correction and the true correction at the middle of the flank is also determined as 0.000064 in. This is negligible and can safely be ignored. In fact, it is much less than the probable error in the hob.

From the values derived in the complete paper the following tabulation is also made to show the various effects of varying the diameter of the hob. (See Fig. 5-B.):

Hob. diam.	= 1.000 in.	2.0000 in.	4.000 in.
x_2	= 0.002695	0.003475	0.004048
y_2	= 0.008912	0.012344	0.014422
$2C'$	= 29° 59′ 26″	30° 0′ 16″	30° 0′ 54″
$F - 2x_2$	= 0.0635	0.0619	0.0608
K	= 0.000064	0.000054	0.000026

From this tabulation it will be seen that the amount of side-cutting at the bottom of the thread (x_2) increases as the diameter of the hob is increased. The height of the fillet at the bottom of the thread (y_2) also increases as the diameter of the hob increases, in fact, it increases about three times as much in this case as x_2. The included angle of the corrected hob ($2C'$) increases very slightly as the diameter of the hob increases. The width of the point of the corrected hob ($F - 2x_2$) varies less than 0.003 in. as the diameter of the hob is increases from 1 in. to 4 in. The dimension K in Fig. 5-B is reduced as the diameter of the hob increases.

The correction for angle used in these solutions is a chordal correction. This shows a slight change in angle as the diameter of the hob varies. A geometrical solution of this side-cutting will show that, except for the fillet at the root of the thread, the profile is unchanged regardless of the diameter of the hob. There-

(Continued on page 62)

Increasing the Capacity of Old Locomotives

By C. B. Smith,[1] Boston, Mass.

The usual policy of the railroads with reference to the purchase of new locomotives and the conversion of old ones is not, in the opinion of the writer, as well provided for as the demands of the service require. The difficulty lies in the fact that shop facilities are inadequate, a large amount of both time and money being unnecessarily consumed in order to keep locomotives in service. The problems of adapting the old-type locomotives to suburban and local service are discussed and the items which are to be considered in any program for increasing locomotive capacity are listed. The author also cites examples of satisfactory reconstruction which justify the improvement program he advocates, and states that the application of all the desirable auxiliaries to old engines is prohibitive without a radical provision for carrying out such a program.

In these days of the high cost of railroading, responsible officers of the mechanical departments realize that the necessity for reducing the cost of all locomotive operation and maintenance is more urgent than ever. Such saving can be accomplished in two ways, one by using new and modern locomotives, the other by rebuilding old types. The purchase of new locomotives, however, is usually confined to the largest units permissible for each type required, and they are equipped with superheaters and other modern devices as selected by the purchaser. Older engines of modern type, but not originally supplied with superheaters, are also being so equipped at general shoppings of these engines on the greater number of the roads of the country, and as rapidly as local conditions will permit.

On the majority of our roads there are still locomotives of the earlier modern types whose general features of construction are satisfactory, and which only require modernizing to make them economical transportation units. Improvements for such classes of locomotives may include, in addition to superheaters, piston valves in place of slide valves, outside valve gears in place of Stephenson motion, and such other improvements as are usually made upon engines at general shoppings.

The replacement or betterment of the older locomotives "in kind" is becoming more of a problem where suburban and local passenger service and branch-line traffic still require the maintenance of the lighter types of locomotives that can handle such traffic. Such engines are periodically returned to the shops for repairs, and the frequency of these shoppings could be reduced and mileage between them increased if the time were taken at one shopping to modernize them. Extensive reconstruction, however, requires a longer shopping period and reduces the number of engines available for road service.

The items which are to be considered in any program for increasing locomotive capacity are:

1 Superheater
2 Pyrometers
3 Brick arch
4 Valve motion
5 Mechanical stoker
6 Power reverse gear
7 Automatic fire door
8 Feedwater heater
9 Improvements in boiler design when new boilers are required
10 Improved boiler circulation
11 Increasing firebox heating surface
12 Flexible staybolts—breakage zones
13 Covering steam pipes
14 Flange oilers
15 Automatic driving-box wedges on heavy locomotives
16 Steam-pipe joints at smokebox
17 Pneumatic bellringer
18 Chime whistle on freight—more audible to train crew.

These items are numbered for convenient reference and do not necessarily indicate the order of importance.

The aggregate of such improvements results in a locomotive which in proportion to its capacity will produce service results comparable with those of entirely modern construction, and at a cost approximately one-half that for a new locomotive of similar capacity. The difficulty in carrying forward an extensive reconstruction program, however, is in finding the shop facilities either on the railroad or among the locomotive builders in order to advance the work at a satisfactory rate of progress. Nevertheless, despite this difficulty the results which could be obtained from the operation of reconstructed locomotives, if they could all be rebuilt within the next few years, would justify a special effort on the part of railroad managements to bring it about.

On roads where the number of old locomotives which warrant rebuilding are sufficient to require a period of more than three years to complete the work, it would seem necessary to arrange for enlargement of shop facilities in order to hasten the reconstruction. If, however, adequate shopping facilities are not forthcoming, the improvement program for locomotives must be confined chiefly to the application of superheaters and the substitution of piston for slide valves; together with the minor but relatively important betterments that may usually be applied at the shopping period.

Some of the engines built within the past ten years have developed weaknesses in frames and in parts of running gear. It has proved justifiable to reconstruct them by substituting new parts of stronger design and thus avoid recurring breakages which interrupt both the road service of these engines and the repairs to others. On roads whose traffic and service conditions now demand and will continue to demand the use of light locomotives for passenger trains and freight trains on branch lines, the better classes of the light locomotives should also receive their share of improvements along with the heavier power.

Old locomotives requiring new boilers have very generally been scrapped, but where light train service demands no heavier engines than formerly, the writer believes it advisable to rebuild such engines with radial-stay boilers, superheaters, new piston-valve cylinders, main frames when necessary, and outside valve gears. If there is to be no increase in the boiler pressure over that formerly carried by the locomotive and the valve motion has given little trouble by breakages, the Stephenson motion may be connected to the piston valves through the usual rocker-shaft connections.

Old locomotives that are unsatisfactory as to wheel arrangement may be rebuilt and changed to another type and service. One road has converted 2-8-0 type or Consolidation locomotives to 0-8-0 switching service by removing the leading truck, applying a new boiler, new cylinders, outside valve gear, power reverse gear, and modifying the frames as required. The boiler was located to properly balance the engine.

The old eight-wheeled, American-type locomotives having crown-bar boilers with deep fireboxes between frames have become obsolete on many large roads, but on the small roads and on branch-line and local train service in much of the New England territory these engines, modernized as far as consistent, should be carefully considered where the traffic conditions warrant.

Because of limiting weight conditions, Mogul or 2-6-0 type locomotives have been assigned to passenger-train service on some outlying divisions. The application of superheater and piston-valve steam chests with outside steam-pipe connections as the principal features of improvement, has increased the economy of these engines, added one passenger car to their tonnage capacity, and reduced train delays. Outside valve gears were not applied, shop limitations preventing, but their addition is desirable.

Atlantic-type locomotives having outside valve gears have had their capacity and economy increased by the application of the superheater. This work permitted the use of the engine in long-distance through service which was not previously successful.

Consolidation locomotives reconstructed with superheaters, new piston-valve cylinders, outside valve gears, new front-frame sections, and frame cross-ties have also had their capacity increased,

(*Continued on page 16*)

[1] Mechanical Engineer, Boston and Maine Railroad.

Abstract of a paper presented at the Annual Meeting, New York, December 7 to 10, 1920, of The American Society of Mechanical Engineers. All papers are subject to revision.

Modernizing Locomotive Terminals

By G. W. RINK,[1] JERSEY CITY, N. J.

The following paper is a discussion of the problem of providing adequate facilities for the proper maintenance of locomotives at engine terminals. The location, size, and general layout of the terminal are dependent on various elements, the two principal factors being character of work to be performed and location of the general locomotive repair shop. The necessity for providing modern facilities is discussed with a view of awakening an interest in this subject, which has an important bearing on the ability of the railroads to handle the increased traffic demands of the country. The various structures which comprise the terminal are treated separately with more or less detail, having in mind that the entire problem must be handled in such a way that it will be of service in modernizing existing locomotive terminals, as well as to provide information of value in designing new terminals. The author has purposely omitted reference to detail construction of buildings as these features generally conform to the railroad's standard practice.

ENGINE terminals play an important part in the operation of the railroad, as the transportation department is at all times entirely dependent upon them for its supply of serviceable power for the movement of both passenger and freight trains. Should the capacity of the terminal or the facilities for making repairs be inadequate, the result will soon reflect itself in more time being required to prepare engines for service and more frequent detention on the road due to failures.

The general layout of the terminals, also the extent of repair facilities to be provided, depend entirely on their location with reference to the general locomotive repair shop. When located in close proximity it is necessary to provide only such facilities as may be necessary to make the general run of roundhouse repairs, depending upon the main shop for the manufacture and supply of a large percentage of materials required for use at the terminal. But when engine terminals are located some distance from the general locomotive repair shops, they should be provided with enlarged facilities so as to perform all the necessary machine, blacksmith, and boiler-shop operations required when making more extensive repairs, and be entirely independent of the main shop. It is important, however, to eliminate at such terminals the manufacture of such standard parts as may be produced elsewhere at less cost when made in quantities. At outlying points where only light repairs are made to maintain locomotives in serviceable condition, such repair facilities as described above are not necessary. In this connection Figs. 1 and 2 are of interest as they illustrate typical layouts of modern locomotive terminals.

The location of the engine terminal with reference to the general locomotive repair shop will have some bearing on the necessity of performing relatively heavy repairs at the terminal. Where they are within reasonable distance of each other, it may be desirable to have a considerable part of the heavy repair work transferred to the main shop, where the repairs can be performed more expeditiously. On the other hand, this class of work has a tendency to interfere with the output of the locomotive repair shop, and especially so if it is found difficult to maintain the necessary quota of class repairs, considering the equipment as a whole. In such cases it would appear more desirable to increase the engine-terminal forces and provide sufficient facilities to at least make Class 5 repairs and the general run of heavy running repairs, including the removal and reapplication of a part or complete set of flues.

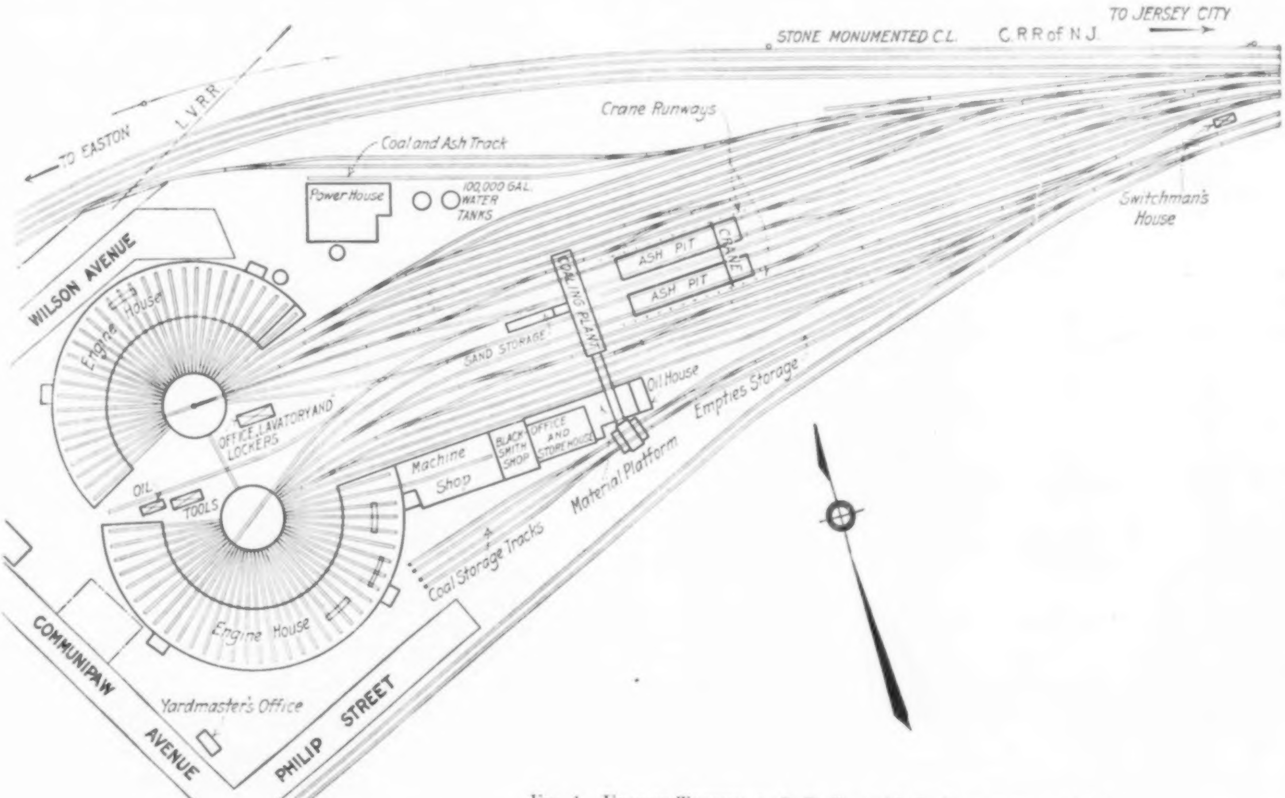

Fig. 1 Engine Terminal, C. R. R. of N. J., Communipaw, N. J.

This terminal handles daily an average of 200 locomotives. It is located 8 miles from the general locomotive repair shop and present facilities only provide for making ordinary repairs.

Where it is found desirable to perform such heavy repair work, it should preferably be done in a small building located adjacent to the machine shop, and provided with several tracks for holding engines and an overhead crane or power-driven locomotive screw hoist to facilitate the removal of all wheels. This feature is very

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desirable, especially if heavy locomotives are to be handled. It also increases the track capacity within the roundhouse to that extent and repairs can be made more promptly and economically.

The arrangement of tracks at the engine terminal, including inbound and outbound tracks, will depend entirely on the location and available space assigned. The successful operation of the terminal requires a complete analytical study of the entire project from an operating standpoint, taking into consideration the number and type of locomotives to be handled and the possible future increase in requirements. The number of locomotives to be handled will determine the size and arrangement of facilities to be provided.

The introduction of numerous specialties on modern locomotives together with the necessity for complying with Interstate Commerce Regulations covering the inspection and testing of locomotives and their appurtenances require a more extensive inspection and maintenance force.

Coaling Stations and Sand Storage

The type of coaling station selected must depend on the number of engines handled, the number of tracks which may be available for coaling engines and the kinds of coal to be handled. Some roads in the East use bituminous, broken anthracite, and buckwheat. Where the quantity of coal handled is small, the locomotives can be coaled from an elevated platform using one-ton buckets or by means of a locomotive crane direct from car. When it is necessary to deliver coal to two or more tracks, a mechanical type of coal-handling apparatus is generally installed. (See Fig. 3). Marked improvements have been made in receiving, hoisting, and distributing equipment, which has resulted in a smaller operating force being required. Measuring devices are also installed for recording the amount of coal delivered to tenders. An electric winch should be provided at large terminals at the loaded-coal-car track so that cars can be hauled to position over the track hopper.

The sandhouse should be located at the coaling station. Sufficient wet-sand storage space should be provided as well as means for drying the sand by coal stove or steam. Compressed air should also be available so that the sand can be delivered to overhead storage bins, having suitable outlets to deliver the sand direct to engine by gravity. All important engine terminals should have a complete installation of this character.

Ash Handling

At small engine terminals provisions are made to handle cinders in various ways, one method is to provide a pit located between rails. Cinders are shoveled to track level and loaded into cars by hand or locomotive crane. This system is satisfactory where but few engines per day are handled. At larger terminals a depressed track is installed adjacent to the pit or ash track and the cinders are shoveled by hand into cars.

Limitations of space at some terminals may not permit the use of longitudinal cinder pits. In such cases, transverse pits have been introduced whereby cinders are dropped directly from ashpan into closed hoppers, located between rails, and then deposited into buckets mounted on trucks, which operate on narrow-gage tracks beneath the hoppers. After filling, the cinder bucket is pushed clear of the cinder track and handled by suitable hoisting mechanism, the cinders being deposited directly into cars. Several running tracks can be equipped as stated, requiring but one long transverse pit beneath and using one or two buckets, depending upon the width of the pit.

A number of recent installations provide for the dumping of the cinders directly into large metal buckets beneath the track. Mechanical means are provided to withdraw the buckets laterally and upward, dumping the contents into the cars.

During recent years the tendency when constructing large terminals has been to install pits filled with water. (See Fig. 4). The cinders drop into the water and move toward the center of the pit, due to the inward slope of the outer wall, and are removed either by a locomotive crane or by an overhead crane traversing the entire length of the pit, the cinders being deposited by means of grab buckets directly into cars located on the loading track.

Steam-jet ash conveyors can be installed to advantage where ample supply of steam is available. This system consists of an 8-in. cast-iron pipe made exceedingly hard to withstand wear, with intakes provided at suitable intervals. The cinders are drawn by suction through the main pipe line and then propelled by means of the steam jet direct to car or storage bin, suitably located. Cinders handled in this manner are not wetted down until they enter storage bin, where a water spray is provided. This type of cinder conveyor has proved very satisfactory for handling cinders in power houses and should give good service when installed in connection with small engine terminals.

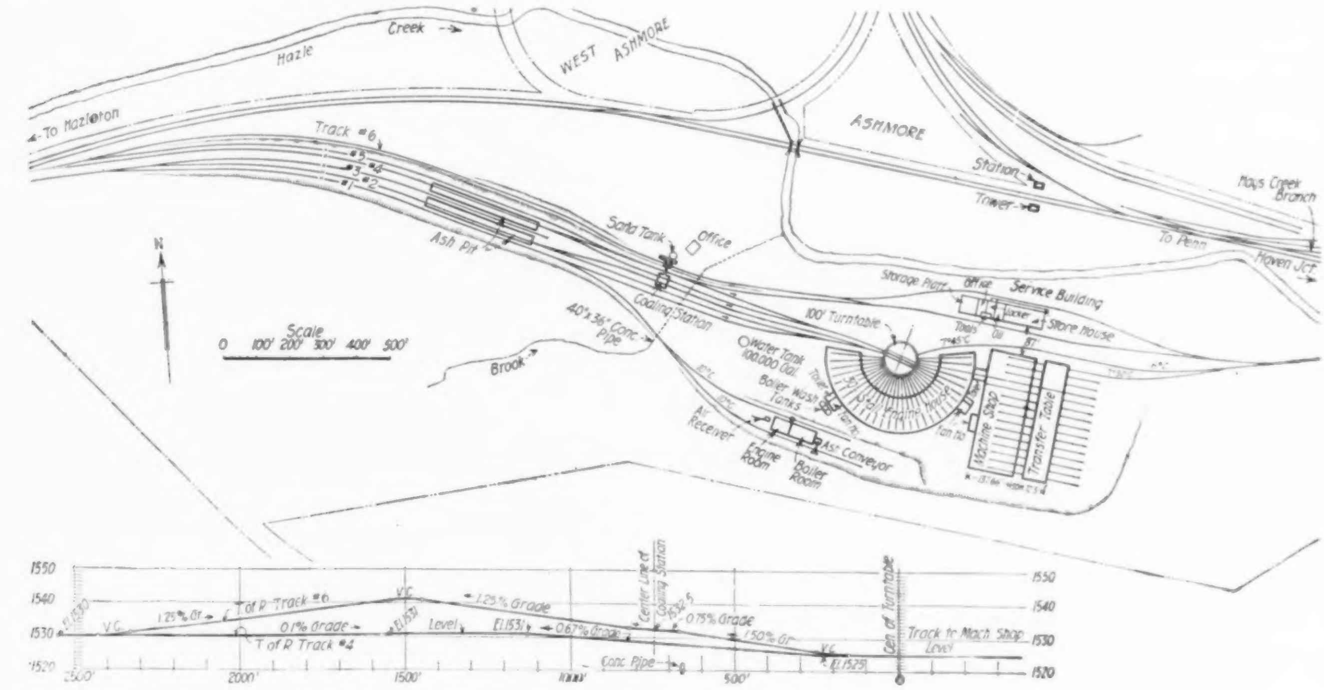

Fig. 2 Engine Terminal, Lehigh Valley R. R., Ashmore, Pa.

This terminal handles daily an average of 70 engines. It is located off the main line and adequate facilities are provided to take care of general repair work in addition to running repairs.

Turntables

The length of turntables installed is generally governed by local conditions, and by the type and wheelbase of locomotives to be turned. The usual length is 100 ft., which is ample in all cases except where large Mallets are handled, when it is desirable to install 110-ft. tables to insure greater leeway for balancing the locomotive under all conditions.

Through-girder and top-deck types are used according to circumstances. For propelling the table electric tractors are generally used, with current supplied either through conduits brought through the center of the table or from overhead collectors mounted on steel frame. Where electric current is not used extensively, pneumatic turntable tractors can be installed, using air taken from trainline of locomotive or from shop line. In the latter case the air supply is usually brought through the center of the table, using a swivel connection.

Inspection Pits

Inspection pits are now being installed at a number of large engine terminals. These are located on the inbound tracks with the view of making inspection of locomotives before they are placed over the cinder pit. Fires can then be withdrawn when the engines pass over the cinder pit, if inspection develops defects which warrant this procedure, thus saving time and expense involved if engine was inspected within the roundhouse after passing over cinder pit. There are many advantages in having inspection made at this time as the foreman by means of pneumatic tubes can be furnished with both the engineer's and inspector's reports showing work to be done before engines are placed within the shop.

These inspection pits are generally made about 100 ft. long, two in number, and protected with a shed. Special arrangements are provided to permit inspectors to enter the pits. Proper drainage and lighting facilities are also required. In lieu of reporting on inspectors' reports such work as loose nuts, missing cotters, etc., it would be desirable to station at these inspection sheds mechanics who can perform this work at once, thus saving time in locating these defects in the shop after being reported.

Heating and Ventilation—Lighting

Heatinga nd ventilation are of first importance in a modern and efficient roundhouse. A combined heating and ventilating system should supply sufficient air for the quick removal of smoke, gas, and vapors. Ventilating sash, louvers and other openings should be provided at the high points of the room to supplement the forced system by directing the flow of air currents and facilitating the removal of hot gases. This feature should be carefully considered, for in roundhouse ventilation it is not so much a question of diluting the air as it is of establishing a positive flow of air which will carry the gases along with it.

It is sometimes necessary, due to the requirements of local ordinances or because the type of house prevents the use of smoke jacks above the locomotive stacks, to install an exhaust system so as to remove gases directly from the locomotive smokestacks. In the latter case connections are made to the smokestacks by means of swinging hoods. This system is not necessary from a ventilating standpoint, and should only be installed where conditions compel its use.

With the usual type of indirect system the fan rooms, one or two in number depending on the size of the house, should be located midway of the length of the house to be served, thereby reducing the temperature drop of the air in the duct as well as the friction head against which the fan must work. The quantity of air supplied together with the number, size, and location of air outlets depends largely on the type, size, and location of the roundhouse. The amount of heat to be supplied with the air is also a variable factor and should have careful study so as to provide a comfortable working temperature under the conditions obtaining in roundhouse operation.

In roundhouse heating it is too often considered sufficient to supply a certain temperature and change of air without consideration of the variable factors governing a proper design. When given the same study and attention as other heating problems it is quite possible to produce a system uniformly satisfactory and economical in operation and first cost.

Adequate daylight facilities through large window areas together with light, cheerful surroundings are highly desirable. The windows should be spaced and located so that daylight conditions are fairly uniform. They should also provide sufficient daylight so that artificial light will be required only during those portions of the day when it would naturally be considered necessary. Good natural and artificial light will reduce accidents, provide greater accuracy in workmanship and simplify the supervision of the men. Fig. 5 is an example of a well-lit roundhouse.

Much needed improvement is desired in connection with artificial lighting of engine terminals. In the roundhouse proper, lights mounted on the outer wall and reflected between engine pits have given satisfactory results when augmented by sufficient lights suspended from the ceiling to afford general illumination. Machine shops, etc., should be provided with a general or overhead lighting and also supplemented by individual lamps conveniently placed, preferably on brackets so that they may be adjusted.

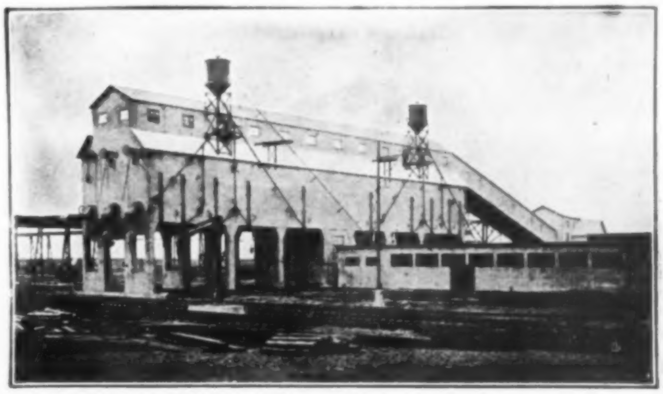

Fig. 3 Coaling Station, C. R. R. of N. J., Communipaw, N. J.

This reinforced-concrete coaling station has a storage capacity of 1600 tons It serves 10 tracks with 3 kinds of coal

For lighting the roundhouse circle, flood lights should be used whenever possible as general illumination will add considerably to the safe movement of locomotives to and from turntable and engine house. Ashpits can be illuminated by rows of reflector lights placed on poles, and similar provisions can be made at other points beyond turntable or by the use of flood lights on the top of coaling stations.

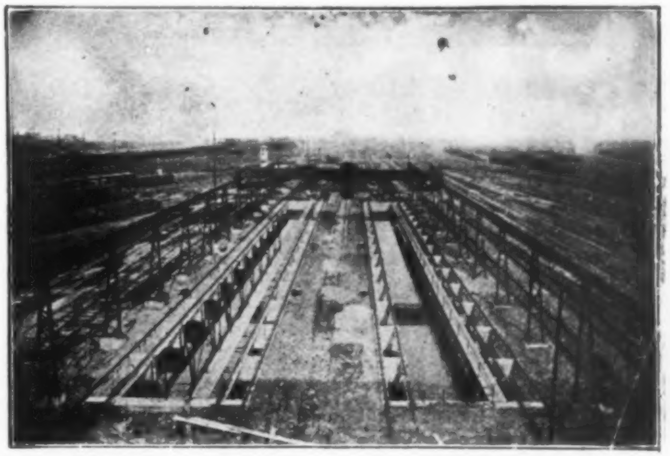

Fig. 4 Ashpits, C. R. R. of N. J., Communipaw, N. J.

This type has been adopted as standard by many roads.

Hot-Water Washout and Refilling System

Facilities should be provided for washing out boilers using hot water under pressure and refilling with hot water after washing. Actual time savings can be made compared with the old system of washing out and refilling with cold water: boilers are washed out more thoroughly and strains within, due to expansion and contraction, are considerably reduced, resulting in decreased cost of boiler maintenance. There are two types of installations for this

purpose in general use, one of which utilizes the blow-off water for washout purposes only, while the other utilizes as much of the blow-off water as necessary for this purpose and the remainder, after being clarified, for refilling purposes. As blow-off water is always soft and becomes clarified soon after storage, it is of course the best water for the generation of steam and its reuse in this manner is responsible for the greater efficiency of the latter type of installations.

Hot-water washout and refilling systems can be economically installed in any size to meet the requirements of any engine terminal. Where such systems have been introduced, there is a material reduction in time required to do this work. Boilers have been blown off, refilled, fired, and steam pressure brought up to 100 lb. within from two to three hours. This does not include such time as may be required to make necessary repairs to boilers.

Wheel-Dropping Facilities

The usual wheel-dropping facilities consist of a drop-pit system

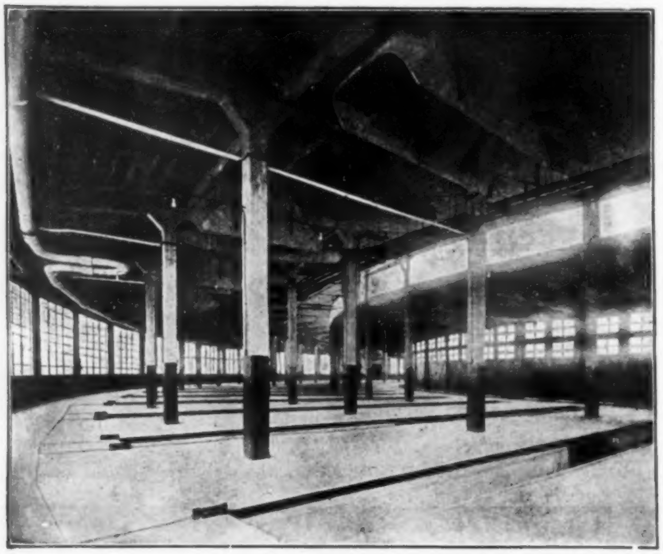

Fig. 5 Interior of Roundhouse, C. R.R. of N. J., Communipaw, N. J.

which provides for depressed pits at right angles to shop track, using telescoping pneumatic or hydraulic jacks for lowering and raising wheels, separate pits and jacks being installed for handling driver and engine-truck wheels. Generally but one pair of wheels can be handled at one operation, and if necessary to drop all drivers in order to take up lateral or change tires, considerable time is lost in moving the engine over the drop pit.

Screw-jack locomotive hoists especially designed for unwheeling locomotives are being more extensively used at engine terminals, and their use has made possible a large saving in both time and labor. These hoists operate with a high degree of safety as compared with the drop-pit system; furthermore they can be located within the roundhouse or installed in a separate building, in which case it would be desirable to also install the wheel lathe and other tools and appliances for taking care of heavy running repairs.

Machine, Boiler and Smith Shops

Old and obsolete tools should be replaced by modern machine tools, which insure increased production at lower costs and the work being done more accurately and promptly and power maintained in better condition. Individual motor drive for the larger machines and group drive for the smaller machines is preferable. Ample space should be provided for this department, and the class of work to be performed will determine the number and type of machines required.

Space for the boiler and smith departments is generally provided adjacent to the machine shop. Facilities should include steam hammer, forges with down-draft hoods (number and size to suit work to be performed), punch and shear, plate-bending rolls, straightening plate, flange, fire, etc. Stock flues, sheet iron and bar iron and steel should be kept outdoors in covered racks.

Autogenous cutting and welding outfits are also considered indispensable and are used principally in making repairs to locomotive fireboxes, engine frames, and in reclaiming miscellaneous parts which can readily be repaired by this process. Provision is also made for the pipefitting, tinsmith and air-brake departments in the machine-shop building. Locker rooms and toilet facilities for both shop men and engine crews are essential. Considerable time in making repairs can be saved by providing jib or overhead cranes in the roundhouse and machine shop, to enable heavy parts of engines to be handled with the least amount of labor.

Oil House and Store House

Oil houses should be separated from other buildings, should be of fireproof construction, and of a size to suit the requirements. The storage tanks are generally in the basement and filled from the floor level above from barrels through pipe line and delivered from storage tanks to the faucets by special hand pumps equipped with measuring devices. When large quantities of oil are used, provisions are made to fill storage tanks in the house direct from tank cars.

This should comprise a structure of ample size, conveniently located to machine shop, with platform and track facilities for handling material to and from cars, building provided with sufficient natural and artificial light, steel shelving, bins, etc., separate alcove for electrical repair shop and provision for office staff on second floor.

Power House

Important engine terminals should be provided with a power plant of sufficient size to take care of the future as well as immediate needs of the terminal. In a number of cases this plant is required to provide steam for thawing snow at switches on main-line track leading to the terminal passenger station and supply heat and light to station buildings, and function in general as a service station. Labor-saving devices should be installed in the way of coal- and ash-handling machinery, automatic stokers and large-capacity overhead coal-storage bunkers. Consideration should also be given to operating with condensers, requiring cooling tower if fresh water is used, the surplus water being delivered to flood ashpit for locomotive cinders if this type is used. Tanks of ample capacity should be located at power house with water mains of proper size supplying water for shop use and filling of tenders at terminal tracks, locating water columns away from switches in cold climates to prevent freezing. At smaller terminals, discarded locomotive boilers are used to furnish steam for power and heat. A close study made of these installations will often reveal the fact that in many cases savings can be effected by the use of modern water-tube boilers.

INCREASING THE CAPACITY OF OLD LOCOMOTIVES

(Continued from page 12)

and have been successfully used in regular freight service on a mountain division greatly needing such power.

When rebuilding locomotives there is a favorable opportunity for replacing old tenders as well, transferring the latter to older locomotives for spare use or as substitutes for damaged equipment. When the condition of old steel tender frames requires that they be replaced, the one-piece steel casting and a larger-capacity tank should be used as both will reduce future expense in repairs. The success of autogenous welding eliminates any objections to the use of large steel castings for fear of breakages.

Tanks should be reconstructed in coal space to permit gravity delivery of the greatest amount of fuel that is possible at the coal gates within reach of the fireman's shovel. Application of power-operated coal pushers should be made to tanks where alterations for the gravity delivery of coal cannot be satisfactorily made and where the service conditions will show a saving in expense by its use over hand methods of shoveling forward coal while on the road or at short lay-over stations. Moving forward the rear coal board or plate on tanks and building higher side plates or "dickies" is one method which has been successful in making the maximum amount of coal accessible at the gates.

Railroad Transportation

By DANIEL E. WILLARD,[1] BALTIMORE, MD.

IT is my understanding that transportation is to be the subject for consideration at this session of your annual conference, and that it is your desire that I should discuss the subject with particular reference to the steam railroad. For the purpose of outlining briefly my own views concerning the larger problem, I would like your permission to read from a report which I submitted to the Council of National Defense in November 1917:

> A nation should have a national transportation system and such a system should embrace and make proper use of all available and suitable agencies. The fullest possible economic coöperation should be encouraged and required between all such agencies. Inasmuch as the business of transportation for hire partakes of a monopolistic character, all agencies so used should be subject to governmental regulation in the public interest.
>
> Among the many agencies of transportation, the following are in most common use: the natural and artificial waterways with the various craft designed to operate thereon; the highways with the different vehicles and contrivances designed to operate thereon; and the specialized roads, such as electric and steam railways with the special equipment designed for each. Other agencies may be developed.
>
> The coördinated transportation system of a nation should be so adjusted that each agency will perform the particular function for which it is best adapted, and, speaking broadly, that country which is provided with the most efficient transportation system—other things being equal—ought to be the most prosperous.

Mr. Theodore N. Vail once told me that for many years it had been his ambition to so develop the telephone system that a man in his own home in any part of the United States could talk with a man in his own home in any other part of the United States, and he very nearly, if not quite, lived to see the realization of his ideal. To my mind the means of transportation should, in effect, be just as universal and all-embracing as the means of communication, and the ideal which Mr. Vail sought to achieve as regards the telephone should be an inspiration to accomplish also the highest development in transportation. Unfortunately, however, we have not yet developed a single agency of transportation of such universal adaptability as the telephone. If we are to have a complete and well-articulated national transportation system, it can only be had, as things are now, by the coördination of a number of different transportation agencies, including the steam and electric railways, the utilization of coastwise and inland waterways, the full economic use of the highways, improved and unimproved, the use of the motor truck, and such other transportation agencies as may be best suited to the particular requirement. Of all the transportation agencies at this time available, particularly for interior service, the steam railroad is undoubtedly the most important.

At the termination of Federal control the steam railroads in the United States had an aggregate length of about 260,000 miles. They also owned in addition thereto approximately 145,000 miles of second, third and other tracks. Further, they owned approximately 2,350,000 freight cars, some 65,000 locomotives and about 55,000 cars designed for passenger-train service—the entire property representing a combined investment of approximately $20,000,000,000. I am now speaking of those roads subject to the jurisdiction of the Interstate Commerce Commission and which are dealt with in the official reports of that body. More than eight hundred separate and independent companies own and operate the mileage which constitutes the Railroad System, so-called, of the United States.

The new Transportation Act provides among other things that in times of emergency the Interstate Commerce Commission shall have authority to treat all of the cars, engines and facilities of all the railroads, regardless of ownership, in such way as to best serve the interests of the public and the commerce of the country.

The law also lays down a definite rule for the guidance of the Interstate Commerce Commission in the matter of fixing rates and in that connection says that rates shall be fixed so as to yield a fair return upon the value of the property devoted to the public use, and further provides that for a period of two years from March 1, 1920, rates *shall* be fixed so as to yield $5^1/_2$ per cent, and *may* be fixed to yield 6 per cent upon the value of the property used for transportation purposes; and the Commission in harmony with the law has fixed rates designed to yield an annual return of 6 per cent upon an aggregate valuation which the Commission tentatively fixed for rate-making purposes in this particular case of about $19,000,000,000.

If this country were fully developed and if we had already reached the peak load which the railroads will be expected to carry, the railroad problem would be a much simpler one than it is under conditions as they actually do exist. Our country has not stopped growing. It is far from being fully developed. Experience of the past demonstrates clearly that at least $1,000,000,000 per annum must be provided as a minimum for capital expenditures for new equipment and facilities necessary to keep the railroads abreast of the transportation requirements of the country. If the Government owned the railroads, it could, of course, if the people so desired and Congress so determined, raise, by general taxation, the funds necessary to provide in whole or in part the additional transportation facilities required, or it could fix rates sufficient to provide either in whole or in part the large sums of new capital needed on that account each year. However, Congress by virtue of the Transportation Act of 1920 has decided that the policy of private ownership and operation of the railroads shall be continued and has undertaken to provide a plan of regulation to make that policy possible and successful. The owners of the properties, that is, the railroad companies, can only obtain new capital provided that they can satisfy investors of their ability not only to pay the agreed rate of interest, but can also give satisfactory assurances of their ability to repay the principal sum itself when due.

Congress undoubtedly believed when it fixed the rule for rate-making in the Transportation Act that it had provided a plan that would enable the railroads to establish and maintain a firm basis of credit, sufficient in fact to enable them to raise in the aggregate at least $1,000,000,000 of new capital each year. It was clearly developed during the hearings preliminary to the passing of the Act that unless the railroads were able to raise that amount of new capital each year, they would not be able to provide adequate facilities to take care of the business of the country and in consequence private ownership as an economic policy would fail. The people in this country cannot afford to experiment with or to have any system of ownership or control of the railroads unless such system is able by and of itself to provide, as needed, the additional facilities necessary to move the growing traffic of the country. Personally, I believe the new Act will enable the railroads to do this. But if it should develop that the rate of return permitted under the law is insufficient to accomplish the end desired, it will then be necessary either to amend the law so as to provide a more liberal return or adopt some other method. The only alternative would seem to be ownership and operation by the Government.

The Transportation Act contains one other far-reaching provision, and in my opinion a wise one. It authorizes, as I have already said, the Interstate Commerce Commission in times of emergency to issue such orders concerning the use of the equipment and facilities of all the railroads as may best serve the requirements of the public for transportation. The law also states that the Commission may in the exercise of this power use such agencies as it may select.

The railway managers shortly after the termination of Federal control, and actuated by a desire to coöperate with the Interstate Commerce Commission in an effort to comply with the real spirit of the new Act, formed an Advisory Committee of eleven railway presidents geographically selected. A Car Service Division has also been established in Washington under the direction of an Executive Manager, who reports to the Advisory Committee.

[1] President, Baltimore and Ohio Railroad.

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This Car Service Division has a staff of about 150 persons, and it receives daily reports from all the railroads in the United States concerning transportation conditions, particularly as affected by car supply. This Car Service Division works in close harmony with the Bureau of Service of the Interstate Commerce Commission, and its purpose is to carry out the intent of the law so far as possible by the voluntary coöperation of the separate railroads.

Since the termination of Federal control more than 170,000 empty box cars have been moved on special orders by the Car Service Division from the south and east to the territory west of the Mississippi River, where they were urgently needed. An equal number of open cars have been moved from the western lines into the eastern territory, where they were needed for coal and other shipments requiring equipment of that character. Many other important transportation matters have been handled by the Car Service Division. At all times there has been a full understanding with the Interstate Commerce Commission. In some instances the Commission's support and interest have been supplemented by special service orders which they have issued.

The condition of the carriers' equipment at the termination of Federal control was much below the standard formerly maintained by the railroads under private control. Furthermore, the Government had not been able to, or in any event did not, provide as much new equipment during the twenty-six months of Government control as the railroads had been in the habit of providing during similar periods. The result was that when the railroads were returned to their owners they were inadequately supplied with equipment, and such equipment as they had was in an impaired condition, while there was a larger volume of business offering for movement than at any time before. The situation was further complicated by the switchmen's strike, which began in Chicago early in April and spread to a greater or less extent over the entire eastern region.

The carriers realizing that they were inadequately equipped to handle the unusual volume of business offering, and appreciating that even if the large amount of new capital necessary to purchase new equipment were available, time also was an element to be reckoned with and some months must necessarily elapse before new facilities could be provided, decided that the important thing to do was to make the best use possible of the facilities already available. With that thought in mind they unanimously pledged their best efforts to increase the daily movement of all freight cars to an average minimum of 30 miles per car per day; to increase the average car loading to a minimum of 30 tons per car, and to reduce the number of cars held out of service awaiting repairs to not more than 4 per cent of the total number of cars owned. If these three standards so set up could all be accomplished concurrently, it would in effect be equivalent to adding over 500,000 cars to those available for service. A number of railroads in the United States are already making more than an average of 30 miles per car per day, and on a number of lines the average car load is much in excess of 30 tons per car, and on some lines the number of cars awaiting repairs is not in excess of 4 per cent. But the railroads have not yet been able as a whole to accomplish the standards which they have set up for themselves and it was not expected that the standards would be immediately reached. I am confident, however, that they will ultimately be reached and exceeded. A very marked improvement has already been made. During the month of August the net ton-mileage movement on Class I railroads was in excess of 42,000,000,000 ton-miles, which was a considerably larger performance than ever accomplished before by the railroads in a similar period of time.

In spite, however, of all that the carriers may be able to do with the existing plant, they will not be able to handle all of the business that this country is even now capable of producing. It should be kept in mind that during the war unusual efforts were made to increase productive capacity in all directions. More ground was cultivated than ever before, and larger crops were raised, existing factories were greatly enlarged and new factories of unprecedented size were built. The productive capacity of the country was thereby greatly increased, for war purposes, it is true, but the development is there and can and will be used largely for peace purposes. During the same period the railroad facilities were not increased at all. In fact, it may almost be said that the capacity of the railroads, that is, the carrying capacity, was less at the termination of Federal control than it was at the beginning, for the reason that during the entire twenty-six months of Federal control the Government bought only about 100,000 freight cars, which was approximately the amount that the railroads had been in the habit of buying during each twelve months' period in the past. The number of locomotives bought during the period of Federal control was also considerably less than ordinarily would be purchased during a similar period. No passenger equipment at all was purchased during the period of Government control. It was found that the railroads with their existing plant could take care of the war situation, and properly all men and material available were used in other directions, but in times of peace the people are not willing to accept the character of service which the railroads gave during the war, nor is it in the interests of the people as a whole that they should be required to accept such service. In order that the carriers may be able to properly handle the business offered in the future, they must make very large expenditures not only for additional cars and engines, but for additional running tracks and particularly for additional terminals.

So far I have assumed that the commerce of the country would depend largely, if not wholly, upon the railroads for transportation. It seems clear to me, however, that it is in the larger public interest that in developing a transportation system which will be adequate to meet the transportation requirements of our growing commerce, each suitable agency of transportation should be used to the extent that it is economically desirable.

Personally, I believe that the situation should be studied as a whole and along the lines indicated in the recommendation which I submitted to the Council of National Defense in 1917. Each transportation agency should be used to the extent that such use is economically desirable. To make less use than that of each available agency would be wasteful and uneconomic, and if a more expensive agency were used when a less expensive one might be equally available, that practice would also be wasteful and uneconomic. I think in the past there has been a tendency on the part of those who happened to be interested in some particular agency, to try to extend its use in many instances beyond the proper economic limits, and this has resulted in unwise expenditures which in the end proved to be uneconomic and consequently unprofitable. Such mistakes ought to be avoided in the future.

Again, to be specific, I do not believe that the motor truck as now developed and operating on any form of highway can compete in the carriage of long-distance traffic with the steam locomotive running on a steel girder properly supported. I do believe, however, that for short-distance traffic and in sparsely settled communities the motor truck, not only on the improved highway but even on the ordinary dirt highway, may be used in conjunction with the railway and thus afford the cheapest form of transportation. I think the same thing may be said also with reference to some of our inland waterways. I think there should be an intelligent effort to develop all agencies of transportation, each within its own sphere, but all so coördinated with each other as to constitute a nation-wide system which would approximate in its effectiveness the efficiency of the telephone system of which I have already spoken.

Undoubtedly it has happened at different times and places in the past that the railroads have taken business where the out-of-pocket cost, not to mention the cost of capital, has been in excess of the entire revenue. The country as a whole would be better off if such business could be handled in such a way as would give reasonable profits to those engaged in the enterprise. There was a time when railway managers were believed to be opposed to the development of other means of transportation which might become competitors for the business which they were hauling or desired to haul. But whatever may have been the attitude of the railway managers in the past, that is not their attitude at the present time and I am certain that they will be glad collectively or individually to coöperate with all other transportation agencies in such way as will inure to the greatest public good, because in the end all enterprises of an individual character must be tested by that rule. Whatever contributes to the public good is likely to endure, and anything inimical to the public good is certain to fail.

Feeders for Railroads

By CHARLES A. MORSE,[1] CHICAGO, ILL.

THE railroads in this country were originally constructed as private enterprises and the majority of them started in a small way. Being private enterprises there was brisk competition and branch lines were constructed to get business which might otherwise go to a competitor. The same thing occurred in the construction of tracks to industries; the railroads assumed all of the expense, but they were able to reimburse themselves by rates charged on the business.

We do not need to follow the history of unrestricted competition on through the period of concessions and rebates as it is past history. Its results were the cause of the beginning of the regulation of railroads and of the gradual evolution of the theory that railroads were not private enterprises but public utilities, and that they should be operated in such a manner as to give everyone the same service.

Early Systems of Regulation

Systems of regulation were inaugurated by the National Government and by the separate states, and like any new power granted it was executed in all manner of ways. Politicians found it a ready excuse to make capital for election to office, and the early practices of railroad managements, while perfectly lawful at the time, were held up as criminal. The result was a wave of popular complaint against the railroads This, as usual, affected the regulatory bodies, and they gave the railroads the worst of every question that came before them.

The ultimate result was that railroads could not raise rates, but on the contrary, rates were continually being lowered, it even going so far that state legislatures undertook to decide what passenger rates should be, with the result that in several states a two-cents-per-mile rate was fixed as the maximum that should be charged on any railroad in these states regardless of whether it was over main lines or branches. The inevitable result was the bankruptcy of many railroads and the cessation of railroad extension and of facilities to take care of the growth of business.

But with the operation of the railroads by the Government it was soon shown that it was lack of facilities and rolling stock rather than private ownership that was handicapping the railroads, and the curtailment of service by the Government, in an effort to operate the railroads and their failure to expend the money necessary to furnish the added facilities, soon brought a demand from the public for a return of the railroads to their owners and an increase in rates that would permit them to furnish the facilities to give the public proper transportation service.

As a result of this the Esch-Cummins Bill was passed, making it incumbent on the Interstate Commerce Commission to permit rates to the railroads that, in addition to paying operating expenses, including a fair amount for depreciation, would yield a return of 6 per cent on a fair value of the property devoted to transportation purposes, either on the railroads as a whole or divided into such groups as the Interstate Commerce Commission might consider advisable.

The Duty of the Interstate Commerce Commission

Now, with a sane and common-sense law by which the railroads are to be permitted to earn a fair return on the money invested in them, and the acknowledgment that the public must pay a rate that will give a fair return on the investment, it becomes the duty of the Interstate Commerce Commission and the railroad managements to make a study of the situation and to see, first, that adequate facilities are provided to give the public the best transportation possible, and, second, to see that this is done at the least cost to the public.

In the past, due to unrestricted competition, many facilities have been duplicated, such as tracks from two or more railroads into the same industry, and branches of two or more railroads running side by side where one railroad would do double the business done by all. The public should not have to pay the cost of maintenance and upkeep, the cost of operation and interest on the investment, of duplicate property.

These branch lines were built in the days when there were ordinary dirt wagon roads and all teaming was done with animals. Today, with the advent of the automobile and motor truck have come the so-called "good roads," and where these roads have been built passenger automobiles can travel 25 to 50 miles per hour and motor trucks loaded with produce or goods can travel 15 miles per hour, or, in other words, at practically the same speed as branch-line passenger and freight trains.

It can readily be seen that with the introduction of a class of locomotive that requires no rails and which can be used by the public at large, the use of the railroad, within the limits of the practical use of a single unit of transportation, must become less and less as good roads are constructed. Why, therefore, should the public be obliged to pay in railroad rates the cost of upkeep, operation, and interest on the cost of a branch line of railroad which they do not need, as with a good hard-surfaced road and no branch line of railroad someone would operate a motor bus for passengers and motor express for less-than-truck-load freight? A careful study should be made of branch lines of railroads, and where they are "good roads" of the hard-surfaced class, over which the business now handled by the railroad can be handled by motor trucks and buses, the question of dismantling the branch line of railroad should be given serious consideration.

The Cost of Branch Lines

Branch lines were formerly cheaply built, at from \$12,000 to \$15,000 per mile; they had narrow roadbeds, light rail, light bridges and fewer ties per rail than main lines; and they were equipped with locomotives that had become too light for main-line traffic. With the constant increase in the weight of locomotives on main lines for the past 15 years, there are no light engines to put on branch lines, and the result is that what are now perhaps light main-line engines but are heavy for branch-line service, are sent to the branches. This, and the rapid increase in the size and axle load of cars, has necessitated the strengthening of branch lines with heavier rail and stronger bridges; more ties to the rail; wider banks and cuts; ballast has had to be applied; with the result that the \$12,000 to \$15,000-branch now costs \$20,000 to \$30,000 per mile, with the increased interest charge on the investment and the increased tax on the public to be added to their taxes for good roads.

The cost per ton-mile for transporting freight and the cost per passenger-mile on the short branch lines are far more than the amount received by the railroad, the result being that the revenue from main-line business must be enough to pay for its cost, and in addition must be enough to cover the deficit on the operation of the branch lines. If, therefore, many of these lines that are tributary to a territory within the limits of auto-bus and auto-truck service could be taken up and abandoned, it would mean a reduction in the cost of main-line service.

On the other hand, on such branch lines as cannot be replaced with motor service and do not connect with or cross other railroads, there should be a rate that would yield an amount sufficient to cover cost of upkeep and operation, and to pay the required return on the value of the line as by this means the main-line rates could be reduced.

Factors to Consider when Abandoning Branch Lines

In considering the question of abandoning a branch line, the first question that comes to the mind of the railroad man is the capital charge. The capital account would have to be credited with the book value of the line abandoned, and operation charged with the same less salvage, but this would be saved in direct outlay in a period of about five years and should be distributed over such a period.

After a careful survey of the situation on each railroad the use-

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less branch lines should be listed and a program made up to cover a period of five to seven years, at the end of which period they would all be up and charged to operation, and capital account on which the public must pay a return would be reduced that much, and in addition the public would be relieved of the cost of operation, maintenance and taxes on these lines.

Branch lines are a necessity and it should not be understood that any attempt is being made to belittle their importance, but the transformation that is constantly going on in large cities in connection with the suburban train service, by which stations near the center of the city are abandoned, due to rapid transit on elevated railroads or subways, furnishing as good or better facilities, is also taking place where short branch lines are being operated, where the business can be taken care of as well, if not better, by motor cars on hard-surfaced wagon roads.

The abandonment of short branch lines of railroad and the delivery of freight at main-line stations also means an increased use of cars, as a car sent to a branch-line station means, as a rule, a day going and a day returning to the main line, which is two car-days lost for each car, which will be saved if the car is loaded at a main-line station.

The abandonment of these branch lines will likewise do away with a lot of small mechanical terminals which are expensive to maintain, also with men employed as station agents and helpers on the branch lines, and it will increase the force at many main-line stations, where better supervision can be given to their work.

Tracks built to a single industry should be owned by the industry served and it should pay all cost of upkeep and all cost of operating. Tracks that lead to several industries should be limited to a single industrial track, which should be operated by one railroad, and all expense of upkeep and operation should be paid by the industries served by the line. Also less-than-carload freight should be collected for all railroads at the various stations in the city and should be taken to a central point by one railroad or terminal company, and there made up into carloads and billed over the railroads to which it is assigned. The cost of this service should be kept separate and added to the carload rate from the consolidation point. In short, those getting special services should pay for that service, and those who do not use the special service but perform a part of it themselves should not have to participate in the cost of this special service.

Rate Making as Affecting Branch Lines

In the effort to compel the reduction of rates, both the federal and state regulatory bodies have encouraged the idea that the heavy-traffic main lines were able to handle traffic so cheaply that they should absorb the losses due to rates being too low on the branches, and so in former times a differential rate often existed and branch lines had higher rates than main lines. Now, however, that it has been decided that the railroads shall have rates that will pay the cost of production of transportation, this cost should be allocated as far as possible and paid by those getting service. With the special service paid for separately it will permit of a reduced rate for main-line service from terminal to terminal, or from intermediate stations to terminals, which is what the vast majority of the people use.

A railroad line will, under present conditions, with the advent of the auto and truck, secure all of the business within 50 miles on either side. In the western portion of the country, however, there are large areas that are not within 50 miles of a railroad, where the quality of the land is just as good as that adjacent to the railroad, but which is not cultivated for lack of transportation facilities. The lack of return on investments in railroads during the past ten years has prevented these railroads from securing the money with which to develop the territory that naturally belonged to them, with the result that the cost per ton-mile has been much more over these lines than it would have been with a proper system of feeders. Some of the more prosperous railroads have systematically constructed feeder lines, and their prosperity under the adverse conditions was largely due to this policy having been carried out for a number of years previous to the strenuous years just preceding the war.

With the requirements of the Transportation Bill that the Interstate Commerce Commission shall pass upon all new extensions, railroads that have undeveloped territory adjacent to their lines which will warrant the construction of feeder lines and increase their main-line business, thus reducing the cost per ton-mile of all business over the main line, should apply to the Interstate Commerce Commission for authority to construct such lines and for a freight and passenger rate over the new lines that will pay the proper return on the investment and the cost of maintenance and operation of the line.

The Construction of Branch Lines

These new lines should be located on the best grade line that the country affords, but in the beginning heavy grades and sharp curvatures should be inserted where they will make a decided saving in first cost; second-hand rail and obsolete and non-standard switch stands, frogs, etc., on hand should be used; station buildings of as cheap a class as possible should be constructed, exemption from taxes for five years should be secured from counties through which such lines are to be built, and everything should be done that will decrease the first cost so that the rates can be made as low as possible while business is being developed along the new lines. Later, when the business has developed and earnings will permit, the class of structures can be improved, and should such a line eventually be extended and become a main line the heavy grades and sharp curvature can be taken out at comparatively small expense.

It has been the practice in many cases in the past to charge but a nominal freight rate on material for these lines and to make no charge for general expenses, interest during construction, services of general officers, etc. This should not be done in the future, for if these expenses are not charged to the new line they will have to be absorbed in the operating expenses of the parent line. Each branch line should carry all charges for labor and material used in connection with its construction.

The same methods should apply in the maintenance and operation of the branch lines: all labor, material and freight for use on a branch line should be charged to it. To follow this out properly there should be graduated prices on material so that if a poorer quality of material, such as ties, rail, fastenings, etc., was used on the branch, it would be charged a cheaper price for this material; the whole matter to be handled so that the branch line is charged with what it gets—no more or no less.

The Operation of Branch Lines

No through rates should be made from points on branch lines; the local rate should be applied to the junction with the main line and main-line rates applied to the shipment over the main line. Shipments from points on the branch lines to points beyond the junction will of course get the benefit of the lower main-line rate, and, as the branch-line mileage will usually be but a small percentage of total distance, will probably cost no more in the aggregate than they do under the present system.

In operating a feeder line constructed to develop the country, a mixed train up one day and back the next is all that should be furnished until business enough has developed to warrant additional service. With the regulation of railroads by the Interstate Commerce Commission this can be done but only if the Interstate Commerce Commission has full authority over rates, both interstate and intrastate.

It will also be necessary, in order to permit the Interstate Commerce Commission to handle the question of new lines and abandonment of old lines, to have all railroad charters issued as national rather than state charters, otherwise it will be impossible to abandon useless lines or to make rates over branch lines that will cover the cost of operation and maintenance and yield a proper return on the investment, as state commissions look at the matter from a local standpoint and will object to the abandonment of lines or increases in rates within their state; whereas transportation is a national problem and should be so handled.

Finally, we shall be unable to make these changes in the maintenance and operation of the railroads unless the Interstate Commerce Commission takes a broad view of the transportation situation and handles its regulation along economic lines as a national rather than local matter, and does not let local interests interfere with the carrying out of a broad national policy.

Railway Terminals and Terminal Yards

By WILLIAM BARCLAY PARSONS,[1] NEW YORK, N. Y.

TERMINALS form the largest item in railway construction cost and the most expensive item of cost in railway operation. What proportion of the total cost is represented by terminals and terminal yards is impossible to say, but a high official of one trunk line entering New York recently made the guess that perhaps the reproduction cost of their end and intermediate terminals, together with equipment, would be as much as all the remainder of the road with its equipment. On the average, does it seem unlikely that at least 30 per cent of the physical valuation of the railways in the United States would be represented by terminals and terminal yards? Any figures short of a detailed valuation must be a guess, though a guess based on experience.

To make a similar guess as to the cost of terminal operation would be more difficult and with perhaps a less accurate basis. There is no segregation of cost figures that will give a reliable estimate as to how much of the total expense of transportation is absorbed by the terminals as compared with that absorbed by train transportation on the open track. The ratio will obviously depend on the length of haul, being greater when the haul is between nearby points such as Philadelphia and New York and less when between Chicago and New York; but on the average can it be safely put as less than the estimated constructive cost ratio of 30 per cent?

Again, the writer would like to give figures as to such cost of final delivery, but conditions vary so much in different cities that no reliable statistics can be given. Several investigations have been made in New York and one established the figure of cost of trucking from the railway freight house to the consignee's warehouse as amounting to as much as 80 per cent of the whole railway charge for carriage from Buffalo or Pittsburgh to New York. Place any figures you like within reason as the part of the total railway charge that should be allocated to the cost of passing a car through a New York terminal yard and the unloading of the goods, and it is evident that it costs much more to handle a ton of freight through New York to the point of ultimate destination than it does to haul that same ton some 400 miles, including in the latter expense the cost incurred in handling the goods in the originating and intermediate terminal yards.

Fixing Terminal Charges

There was a time when this question of railway terminal charge was largely one of dispute between shipper and railway companies. At strongly competitive points the companies held rigorously to any special convenience of advantageous location that they might enjoy to the exclusion of other lines. Today we are entering upon a new era of railway economy. To a great extent competition is removed and there is established the base principle that rates must be not only geographically equitable, but should be so fixed by governmental authority as to give a minimum net return which is also substantially a maximum net return on physical valuation.

It is obvious that rates can be raised so high that the resultant gross returns will show declines and not increases. Managers must therefore see that rates are not carried beyond the critical point, or, to put it another way, they must see that business is conducted economically. But that responsibility is also placed on the shipper. If he would avoid further raises in rates he can aid by focusing public attention on the unnecessary burdens placed by legislation on transportation companies, on the failure of the transportation companies to use their properties in the best manner to produce the most economical results for all concerned, or on the failure of public authorities to coöperate with the transportation companies and with each other.

Let us briefly consider terminals and terminal yards from this point of view. The capital invested is probably 30 per cent of all railway capital, and the cost of operation is perhaps as high a proportion of the total operating cost. Every reduction in cost of terminal operation, therefore, will result in a sensible reduction in operating expense, which reduction inures first to the benefit of the shipper and only to the benefit of the company when an increase in rates no longer produces an increase in gross returns.

How can savings in terminal expense be obtained? In the old competitive days it was necessary for each company to have its own complete terminals and to prevent competitors from obtaining facilities as ample or so well located. There resulted, consequently, as many terminal yards as there were companies, and frequently each terminal yard had its own separate arrangement for the handling of every class of commodity. Under the present law the systems are not actually combined, nevertheless the cut-throat competition has been removed, and the companies are not only free but are encouraged to eliminate wasteful duplication. The Chicago Terminal Commission has already answered this question by saying that "there are decided advantages in coöperative operation."

In 1918 the railways in different parts of the country began to put such coöperative operation in effect and reports show that savings of very measurable proportions resulted. In the northwestern, central-western and southwestern sections covering twenty-eight states, estimated annual savings amounting to $5,750,000 have already been obtained. Would there not be really great savings if all the terminal facilities in all our cities should be pooled and duplication be avoided?

The Cost of Terminal Operation

How can terminals be more economically operated is another question. Many of our terminals, especially passenger, are seriously overburdened, and yet on account of surrounding urban development the facilities cannot be increased. The commuter seeing our great stations crowded morning and evening does not realize that during the remaining twenty hours the efficiency is gradually reduced to zero, giving a very low average load factor. Would electric operation result in simplification and economy? At end terminals with electric equipment, local or suburban trains which constitute the great majority of passenger trains could be handled in and out and do their own switching without calling for shifting engines. Between end terminals the engine runs could be lengthened to any reasonable degree. The electric locomotive, unlike his steam brother, does not have to be taken to a roundhouse after a limited performance.

The question has been put, "What can the railways do to reduce the cost of terminal operation?" The complement question can also be put, "What can the shippers do?" A few years ago shippers used both railway freight houses and cars as places of free storage for long and indefinite periods. High demurrage charges rigorously enforced, however, have greatly reduced this irregular and wasteful proceeding, and in fairness to all parties it should be stopped entirely. There is perhaps only one way in which this can be done and that is by having the railway companies do all the unloading and delivery, either by their own agencies or by some authorized single agent acting for them. To cover the cost of this delivery service, freight rates would have to be raised correspondingly, but the total would be much less than the present cost to shippers, which is a combination of the railway charge and their own trucking expense.

New York Terminals a National Question

At a meeting in New York where terminals are being discussed one cannot refrain from speaking of New York's terminals, nor is it proper to refrain because New York's terminals are really the affair of the whole country. In what can be called the Metropolitan District, embracing a part of New Jersey as well as the City of New York, there is located nearly one-twelfth of the whole population of the United States, and this same district is the greatest manufacturing center of the United States. Forty per cent of the export and import traffic of the whole country passes through the port.

(Continued on page 62)

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Abstract of paper presented at the Annual Meeting, New York, December 7 to 10, 1920, of The American Society of Mechanical Engineers. All papers are subject to revision.

Fuel and Its Conservation

A Group of Papers Dealing with The Fuel Supply of the World, Fuel Conservation, Distillation of Fuels, and Form Value of Energy, with Discussion Thereon, Which Were Presented at the 1920 Annual Meeting of the A.S.M.E.

ONE of the most notable features of the 1920 Annual Meeting of The American Society of Mechanical Engineers was the interest aroused in the sessions devoted to fuel and its conservation. These were held under the auspices of the newly formed Professional Section on Fuels, and in order that all might have an opportunity to express their views concerning this most vital question, two adjourned sessions were necessary. The papers presented were by L. P. Breckenridge who spoke on the Fuel Supply of the World; David Moffat Myers, on Fuel Conservation; O. P. Hood, on Distillation of Fuels as Applied to Coal and Lignite; and Messrs. C. G. Gilbert and J. E. Pogue, on Form Value of Energy in Relation to Its Production, Transportation and Application. Abstracts of all of these papers are presented below, as well as an account of the discussion which they brought forth.

THE FUEL SUPPLY OF THE WORLD

By L. P. BRECKENRIDGE,[1] NEW HAVEN, CONN.

FOOD and fuel are basic necessities of our present-day existence. Here in America as recently as one hundred years ago men were selecting a place to live where food could easily be produced and where wood was nearby for fuel and for the building of the home itself. Up to 1820 fuel was needed primarily for cooking food and for keeping warm. At that time power was produced by wind for the sailing vessels and by falling water for the grist mill, sawmill, cotton mill, woolen mill, and forge. The total amount of coal mined in the United States up to the end of the year 1840 was only 12,000,000 tons, an amount which is now produced in six working days. In fact, the total coal mined up to the end of 1880 was not more than 1,000,000,000 tons, an amount now produced in twenty months.

Fifty years ago the total coal production of the United States was less than one ton per capita (0.96 ton). Today it is slightly over 6 tons. This great increase is accounted for primarily by our growth as a manufacturing nation, involving great increases in the requirements for transportation, but to this must be added the evident fact that we have surrounded ourselves with many comforts, then unknown, as well as luxuries which still are never found in many foreign countries.

We are rich indeed in fuel, but our wealth of fuel resources should not make us wasteful of these resources which are a world need and which, when once used, may never be replaced. It is hoped that a study of the facts presented in Tables 1 to 7 will serve to emphasize the larger problems of fuel as related to their place of production, extent of exhaustion, methods of transportation and especially their methods of use, pointing—as all the facts do—to the great necessity for coöperation for conservation.

The time has come when the fuel problems of the world must be given consideration in a large way. Communication and transportation have made all countries of the world near neighbors. Food and fuel are essential to the world's life and progress. The United States now for the first time has cargo vessels. It will fail in its duty if it does not make wise use of its resources and its facilities to aid the people of the world.

The title of each of the tables given is sufficient to indicate its import. War conditions have made many temporary disturbances in statistics of this character, and for this reason it has seemed wise in some cases to choose prewar conditions where it is simply the trend of progress that it is desired to indicate.

A Plea for Thrift and Conservation

The difficulty of securing a supply of coal coupled with the high price paid for it, has in itself brought about a desire to exercise all possible care in its use. The public at large more and more realizes the need of coöperation to secure conservation in some large way. It is in connection with the last plan, "coöperation for conservation" rather than on "individual thrift" that the writer sees the most promising chance for initial success. Especially is this true as a wise first step. Individual thrift should always be practiced, but the large savings of fuel that could be made by coöperation are way beyond anything that could be expected from individual effort. The suggestions for coal conservation which follow are not new—some of them are already begun—but it is only when all of them are fully realized that we shall be able to feel that we are really making satisfactory progress in preventing waste of fuel, as well as waste in labor and capital, which are required to produce and transport it.

How to Prevent Waste of Coal

1 Extend as rapidly as possible improved methods of mining coal. Under present conditions, one-third the bituminous and one-half the anthracite coal is left in the mine under such conditions that recovery is practically impossible.

2 Extend improved methods of "preparation" of coal at the mines. A premium might well be allowed for well-prepared coal, or a penalty imposed for impure coal.

3 Reduce the hazards of coal mining. For every 1,000,000 tons of coal mined there are between four and five fatalities.

4 Operate the mines a maximum number of days each year. Mines are operated from 200 to 240 days in one year. Lost time is due to three principal causes: shortage of cars, shortage of labor or strikes, and mine disability.

5 Utilize a larger amount of the mine waste. Briquetted fuel, pulverized fuel and electricity from mine waste are all possible of successful development.

6 Increase the use of by-product coke ovens. The by-products wasted by beehive coking are equal to fully 600 lb. of coal per ton of coke produced. Increase the use of domestic coke from the local gas plant.

7 Extend the use of blast-furnace gas for power generation. Much progress has recently been made. It will require coöperative effort to utilize fully the power which might be made from blast-furnace gas.

8 Extend the use of the gas producer, the gas engine and the heavy-oil engine for power generation, more especially where electrical energy is not available. Develop the lignite fields—by power from gas producers—and briquetted fuel for domestic use.

9 Extend water-power development. Hydroelectric power often combined with steam power offers large possibilities for saving coal. It will require comprehensive expert study before any new development can be undertaken, or satisfactory financial returns may not be possible.

10 Extend very generally the best-known performance of locomotives. The better locomotives of 1920 use only two-thirds of the coal required 20 years ago to do the same work. Much saving should be expected in the operation of steam locomotives. Electrification will save coal where water power is conveniently available. Instructions to firemen should be given and followed up even more carefully than in the past.

11 Encourage the tendency of the small industrial plant to purchase its power. The best coal is often sent to the small plant. Small plants, like individuals, should be examined by experts and all reasonable effort made to conserve fuel. Correct equipment and correct methods of operation would save 20 to 25 per cent of the coal used in industrial plants. It is the coal saved by the industries that will set free transportation facilities sorely needed for other purposes than hauling coal. One-third of the railroad tonnage is coal.

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12 Furnish homes and public buildings with correct and simple instructions for operating the furnace, heating boiler and stove. This involves using fuel with suitable equipment for burning it. This should result in saving from 10 to 15 per cent of the domestic coal consumed.

TABLE 1 ESTIMATED RESERVE COAL AND LIGNITE SUPPLY OF PRINCIPAL COAL-PRODUCING COUNTRIES OF THE WORLD

Countries	Supply in Billion Tons	Source of Information
United States	3,527	United States Geological Survey
China	1,500	Secretary Bituminous Coal Trade Association
Great Britain	180	British Royal Commission
Germany	164	Secretary Bituminous Coal Trade Association
Canada	100	Canadian Authorities
Japan	50	
Austria-Hungary	30	
France	25	Secretary Bituminous Coal Trade Association
Belgium	20	
Chile	2	

TABLE 2 ANNUAL PRODUCTION OF COAL IN THE UNITED STATES (1880–1920)

	Millions of Short Tons			Millions of Short Tons	
Year	Anthracite	Bituminous	Year	Anthracite	Bituminous
1880	30	44	1915	86	435
1890	42	110	1916	87	460
1900	60	210	1917	88	500
1905	70	310	1918	87	566
1910	82	420	1919	86	420
1914	84	420	1920	84	(510)?

TABLE 3 THE COAL-PRODUCING AND USING STATES IN 1915

	Millions of Tons			
	Bituminous		Anthracite	
States	Producing	Using	Producing	Using
Pennsylvania	158	66	89	23
West Virginia	77	6		
Illinois	59	40		3
Ohio	22	22		
Kentucky	21	5		
Indiana	17	16		
Alabama	15	8		
Colorado	9	5		
Virginia	8	4		
Iowa	8	7		
Kansas	7	...		..
Wyoming	5	...		..
Tennessee	6	...		..
New York	...	17		21
New England	...	21		14
New Jersey	...	4		8
Wisconsin	...	8		2
Minnesota	...	6		2
Maryland and D.C	...	...		2
Michigan	...	10		..
Missouri	...	8		..
All other states	29	37		5
Railroads	...	122		6
Exported	...	19		4

TABLE 4 INDUSTRIES USING BITUMINOUS COAL IN THE UNITED STATES (1914)

Industry	Short Tons
Coke	50,467,000
Steel Works	20,343,000
Clay Products	8,566,000
Cement	6,731,000
Paper and Wood Pulp	6,268,000
Gas (Heat and Light)	6,076,000
Railroad Shops	5,486,000
Cotton Goods	3,579,000
Ice Manufacture	3,386,000
Foundry and Machine Shop	2,913,000
Meat Packing	2,786,000
Malt Liquors	2,742,000
Chemicals	2,607,000
Glass	2,252,000
Petroleum Refining	2,045,000
Blast Furnaces	1,892,000
Flour and Grist-Mill Products	1,809,000
Woolen and Worsted Goods	1,544,000
Oil, Cottonseed and Coke	1,232,000
Leather	1,124,000
Zinc Smelting and Refining	1,066,000
Lumber Products	885,000
Sugar Refining	875,000
Copper Smelting and Refining	812,000
Electrical Machinery	769,000
Paving Materials	665,000
Glucose and Starch	648,000
Pottery	577,000
Agricultural Implements	555,000
Wine	523,000
Soap	515,000
Automobiles	464,000
Fertilizers	433,000

TABLE 5 COMPOSITION AND HEATING VALUES OF DIFFERENT RANKS OF COAL COMPUTED ON ASH-FREE BASIS

Rank of Coal	Heating Value, B.t.u.	Fixed Carbon, Per Cent	Volatile, Per Cent	Moisture, Per Cent
Anthracite	14,440	95.6	1.2	3.2
Semi-anthracite	14,880	83.8	10.2	6.0
High-Rank Semi-bituminous	15,360	83.4	11.6	5.0
Low-Rank Semi-bituminous	15,480	75.0	22.0	3.0
High-Rank Bituminous	15,160	64.6	32.2	3.2
Medium Rank Bituminous	13,880	54.2	40.8	5.0
Low-Rank Bituminous	12,880	47.0	41.4	11.6
Sub-bituminous	9,720	42.4	34.2	23.4
Lignite	7,400	37.8	18.8	43.4

TABLE 6 WORLD PRODUCTION OF PETROLEUM FOR TWO TYPICAL YEARS (1916–1918)

	Barrels of 42 Gal.	
Countries	1916	1918
United States	300,800,000	355,927,716
Mexico	39,800,000	63,828,327
Russia	72,800,000	40,256,182
Dutch East Indies	13,200,000	12,846,365
Rumania	10,100,000	8,730,235
India	8,200,000	8,000,000
Persia	.....	7,200,000
Galicia	6,400,000	5,591,620
Peru	2,600,000	2,536,102
Japan and Formosa	3,000,000	2,446,069
Egypt	.....	2,079,750
Trinidad	1,000,000	2,000,000
Argentina	870,000	1,321,315
Germany	1,000,000	711,260
Canada	.....	304,741
Venezuela	.....	190,080
Italy	.....	35,953
Total	460,450,000	514,208,715

TABLE 7 ONE YEAR'S FUEL REQUIREMENTS OF THE UNITED STATES AND THEIR COAL EQUIVALENT (13,000 B.t.u.)

Kind of Fuel	One Year's Fuel Consumption	Approx. Coal Equivalent (Tons-2000 lb.)	Conversion factors
(1) Peat	25 thousand tons	12,500	2 tons = 1 ton coal
(2) Natural Gas	800 billion cu. ft.	27,000,000	30,000 cu. ft. = 1 ton coal
(3) Wood	80 million cords	40,000,000	2 cords = 1 ton coal
(4) Water power	7.5 million developed water horsepower	55,000,000	33 per cent load factor, 5 lb. coal per hp.
(5) Petroleum	360 million barrels	100,000,000	3.6 bbl. = 1 ton coal
(6) Coal	650 million tons	650,000,000	....
Total		872,012,500	

13 Extend the custom of coal storage. The facts relating to this important practice are now available. Coal may be safely stored and the load curve on the mining industry may be much improved. The coal should be stored at or near its point of consumption.

14 Extend electrification. The full use of electrical energy offers the most promising means of saving coal. Conservation by coöperation of water power, steam power and electricity opens up large possibilities for saving coal, capital and labor. This is contemplated by the superpower plan now being investigated by the Department of the Interior and a report is in preparation by an engineering staff which will set forth the facts as to: (*a*) Needs for superpower, (*b*) characteristics of an installation, (*c*) location of suitable superpower lines, (*d*) estimated costs, (*e*) estimated economies and other details.

DISTILLATION OF FUELS AS APPLIED TO COAL AND LIGNITE

By O. P. HOOD,[1] WASHINGTON, D. C.

MUCH has been written on the subject of the distillation of coal, covering the field from the intricate chemical reactions involved to the economic aspects having a bearing on statecraft. The subject is by no means new since men of perception have for many years pointed out the fact that coal is a raw material from which many values other than the heat of direct combustion can be obtained.

The growing appreciation of these values by the layman as a result of present writing is, however, new. There is a widespread feeling that we are not wise in our present methods of using coal. It is well to awaken general interest in this subject, and presenting the matter in exaggerated form to more quickly convey an impression is somewhat justifiable, but it is quite possible to overdo the matter. When coal is used raw for heat generation it should always be with a proper understanding that this material might, under more favorable circumstances, be used for higher purposes. Beside major products of coke, gas, and pitch, an alluring chain of oils, dyes, and medicinals might have been produced.

While all this is possible it does not warrant the conclusion that all coal should be made to yield the last-mentioned products. Because wheat can be made into cake the market for bread is not to disappear. There will always be much use for raw coal, for in this form the individual has the disposition of a maximum amount of energy with the least fixed liability. It must be recognized,

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therefore, that the distillation of coal is not for universal application, but that it will find its appropriate field of usefulness together with other and cruder methods.

The layman is likely to overlook the fact that processing of coal to obtain more than one or two products is necessarily a large enterprise and not to be entered into with small means or on a limited scale. Even on a large scale the tendency has been to look to a single product to justify the installation; e.g., in the production of metallurgical coke the gas has been wasted, and in the production of city gas the disposal of coke was a problem.

The investment required in large plants for coal processing is so great that it is no reproach to forego this form of ultimate economy so long as our savings are more needed for development in other directions. In other words, conservation of capital is as necessary as conservation of raw material.

There are, however, rapidly developing fields in which the processing of coal is extremely desirable and is practicable. These fields are made apparent by the greatly increased cost of coal, by a general realization that there is a limit to easily won high-grade coal, by the decline of natural-gas supply, the increased cost of transportation, and a growing appreciation of and dependence upon fluid fuels, both gas and oil.

There is a popular hope that if elements of higher value are recovered from coal by distillation, the remaining fixed carbon can be sold at a price lower than the raw fuel; in other words, that coke as a domestic fuel can be sold at a cheap price. Where in any process a chain of products is produced, the actual cost of production of each is largely a matter of bookkeeping and each is priced at what the market will bear. So far, the market has absorbed coke at a price which leaves little hope for cheap fuel from this source and it is not likely that processed coal can yield cheap fuel. It is more likely to produce a fuel whose special qualities of cleanliness and smokelessness will command a good price and supplement our declining store of anthracite coal. There is also the hope that by extensive distillation and other processes manufactured gas may reinforce our rapidly disappearing natural gas. There is little to justify the hope that relative prices for heat units in the form of gas can ever again be as low as they have been in the case of natural gas, for it is now recognized that even natural gas has been sold too cheaply to return the investment at the end of the producing period.

Processes of Distillation

The fact that motor and other oils can be obtained from coal distillates and that there is a market for all that can be produced, strengthens the position of distillation processes. There is a growing appreciation of the fact that the character of coal distillates is quite as much a factor of the process as of the coal used. The amount and quality of the distillates is determined by the heat experience of the primary complex constituents of the coal, so that variation in the engineering structure and mechanism of the apparatus, together with temperature treatment, gives opportunity for a variety of processes and results. These processes can, therefore, within limits, be fitted to the major products desired. A great deal of attention has been given to distillation resulting from temperatures not exceeding about 1400 deg. fahr., which are lower than used in coke-oven or gas-retort distillation. Prof. S. W. Parr states that "in general, it is believed that all the products of decomposition have a higher intrinsic value as delivered under low-temperature conditions chiefly because excessive secondary decompositions are avoided." With the usual methods and lower temperatures there will be considerable difficulty in transmitting heat to coal at a sufficient rate to obtain reasonable capacities from a given investment and in this particular low-temperature distillation is at a great disadvantage, which must be equalized by a greater refinement of its products. It is therefore hard to see how low-temperature distillation can be expected to yield a cheap fuel.

Distillation of coal in by-product coke ovens is already the major process in the production of metallurgical coke, and in a few years probably only the peak load of productive years will be carried by beehive ovens. The gas produced is used in the adjacent industries which determine the location of the plant, and much of the tar is burned instead of fuel oil. An appreciable addition to the supply of motor fuels is made by the benzol which is recovered, and ammonium sulphate for use as fertilizer is recovered in quantity.

A return to distillation methods in the city gas industry is indicated now that gas oil is no longer cheap for the enrichment of water gas and an outlet for coke in domestic heating service becomes more assured. This is the most favorable field for the expansion of distillation processes.

There is great need for a high-class domestic fuel in the lignite areas of the United States where there are large supplies of low-grade fuel. The increased difficulties and cost of transportation of eastern coals into these districts makes the problem a specially urgent one. Experimental work has shown the possibility of applying distillation methods to lignite, obtaining gas, tar, ammonium sulphate and a carbonized residue of excellent heating value. In most regions where this need exists the solid fuel would be the main objective of the process, possibly wasting the others. The char is too fine for domestic use without briquetting, but when put in proper form it makes a fuel comparable with anthracite.

In the southern lignite area there is also a need of developing a distillation process which will make lignite available for the production of city gas. This seems quite possible from the indications of laboratory work, but in both of these fields there is no commercial development. It seems as though the laboratory and small-sized experimental plant had contributed about all that it could and the business awaits that longer step which must be taken to realize these results in full-sized apparatus. In fact, many fuel-distilling processes seem to have reached this interesting stage of expectancy.

FUEL CONSERVATION

By DAVID MOFFAT MYERS,[1] NEW YORK, N. Y.

SEVENTY-FIVE to one hundred million tons of coal per year could be saved by the adoption in the United States of well-known and well-tried methods of fuel conservation, and this saving would be in addition to a similar reduction in the consumption of other fuels. The writer's experience in the Fuel Engineering Section of the United States Fuel Administration demonstrated without possible doubt that such conservation would involve no experimental features, and that it could be readily accomplished by the simple adoption of sound engineering principles in the use of fuel by consumers. Prevention of waste is merely a matter of the application of well-known engineering principles.

Based upon only 75,000,000 tons, the money saving would be \$450,000,000 per year, or enough to pay nearly one-half the interest of our national war debt.

The transportation of coal would be relieved to an extent equivalent to a million and a half 50-ton carloads per year, or 50 per cent more than the coal-carrying capacity of the Pennsylvania Railroad lines east of Pittsburgh. The significance of this will be realized when it is stated that the chief difficulty in securing coal today is due to lack of transportation facilities.

The services of 75,000 miners would be conserved, so that the same force would be able to handle the natural increase in mining production. The additional labor connected with the loading, transportation, and unloading and firing of a million and a half less cars of coal per year would also be eliminated.

Fuel conservation is good for other countries, as it enables us to do our part in supplying their markets. It should be emphasized at this point that the kind of conservation which the writer has in mind is "constructive conservation," which means using fuel efficiently without reduction in the output of our manufactured products and without the slowing down of any of the natural phases of our national and social life. It is necessary to inject this statement owing to the fact that during the war "destructive conservation" was also largely practiced, which simply mean the cutting-off of coal supply to various industries and uses with the consequent impoverishment of our industrial and social life.

All consumers of coal would benefit financially by a program of constructive conservation. During the war, by the adoption of

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very simple rules governing methods of operation alone in our power plants and on our railroads, an annual saving of 25,000,000 tons of coal per year was effected with the program in operation in twenty-five states for an average time of less than four months. It was impossible, at that time, owing to conditions imposed by the war, to adopt measures affecting also the design or equipment connected with the use of fuel. A future program should include such measures. The efficiency of any process that is connected with fuel or any other material is equal to the efficiency of the operation multiplied by the efficiency of the equipment. In other words, the man multiplied by the machine.

The Waste of Fuel in the United States

There is at present a huge and unnecessary waste of fuel in this country. The waste is everywhere. There is not an industrial plant in the country where 10 to 30 per cent saving of fuel might not be effected by common-sense engineering. Some of the items relating to this waste are as follows:

(1) Waste in the boiler plant, including the very large item of inefficient combustion of fuel under stationary and locomotive boilers. Sixty-seven per cent of all the coal mined in this country is consumed for the purpose of making steam on land.

(2) Coal consumed in the old-fashioned, wasteful beehive coke ovens represents 9.3 per cent of the total. Only 4.3 per cent is consumed in the by-product coke ovens.

(3) In domestic heating it is estimated that 12 per cent, of the coal is used. Very large savings were made in this department during the war, and much more can be done by proper conservation methods. The psychological importance of emphasizing fuel economy in this field is evident owing to the fact that it would deal with 20,000,000 people or householders, whereas by comparison fuel conservation in the industries would deal with only 200,000 plant managements and those of the railroads.

(4) Fuel is extravagantly wasted by improper use of steam after its generation. For instance, by the use of:

(*a*) Inefficient types of prime movers
(*b*) Careless maintenance of power-consuming machinery
(*c*) Ill-advised installations unsuited to the purpose they would fulfil
(*d*) Huge volumes of wasted exhaust steam expelled to the atmosphere or to condensers, and live steam used for heating without first developing its quota of energy
(*e*) Unnecessary use of live steam where exhaust steam with proper engineering would fully meet the requirements
(*f*) Badly designed and ill-kept transmission systems.

Of these forms of waste item (*d*) needs the greatest emphasis. Everyone knows steam is being wasted when they see clouds of exhaust blowing out into the air, but how many people (not engineers) realize that our modern and highly efficient central stations are guilty of wasting some 80 per cent of the heat of the steam into the condenser, while at the same time, particularly during the heating season, hundreds of buildings and factories in the vicinity are burning thousands upon thousands of tons of coal for heating purposes, and that the owners of these would gladly dispense with their expensive heating plants if the central station would sell them heat as well as power.

Fuel Savings in Industrial and Private Plants

The other side of the problem relates to the private plants, each of which must be diagnosed according to the merits of the case. Many industrial plants can utilize all of the exhaust steam from their own power plants all the year round, and in such cases their power is merely a by-product of their heating fuel. If they were to shut down their engines or turbines they would still have to burn about 90 per cent of their former coal consumption, so that only 10 per cent of their engine water rate is chargeable to power. Such a plant of course produces its own power so cheaply that no central-station condensing power plant will ever be able to compete with it. Frequently it would easily be able to generate more power than it can use without wasting any exhaust steam, under which circumstances it should be enabled to sell its surplus power to a central-station system.

The other extreme exists when the private plant has no use for heat and wastes all of its exhaust to the atmosphere. Coal, and money, too, in many instances, would be saved if the owner shut down his engines and purchased power from a more efficient central plant. There are many stages between these two extremes. For instance, the private plant just mentioned, if the power requirements were sufficiently large, could afford to install modern equipment and make its own power more cheaply than it could buy it. Coal might not be saved over the plan of buying power from the central station, but money would. A very common case is that of the private plant that can utilize all of its exhaust heat during the heating months but wastes it through the non-heating months. Such a plant should make its own power in cold weather and buy it in warm weather. What we need to develop is a flexible plan of coöperation between the central power stations and the privately owned plants.

The superpower system advocated by W. S. Murray, apparently fails to consider the vital factor of industrial and building heating, and unless this factor is interwoven in the system in the manner the writer has indicated above, the waste of steam and fuel (to the condenser) in large central stations would be augmented rather than reduced. If power alone were the only consideration necessary, Mr. Murray's plan would avoid this important fault. As applied to the railroads alone, which consume 28 per cent of all the coal we produce, the plan would appear to have many important advantages.

Our Failing Supply of Fuel

The need of a definite policy of fuel conservation is urgent. Natural gas, the most nearly ideal of all our natural fuels, today is practically gone. Inside of three years there will be no more available for industrial uses, and all owing to our failure to demand a definite policy of conservation. We permitted instead a definite policy of waste.

The next natural fuel to go will be oil. The supply in the United States it is estimated will be used and wasted out of existence in 20 to 30 years. Our production is stated at one million barrels of crude oil a day, which is more than 60 per cent of the world's total output, but this is not enough for our present domestic consumption. The peak of production will be reached in a very few years, whereas the consumption is increasing steadily. The demand for motor fuels is the greatest of all the items of consumption, and fuel oils is said to be the next largest. A bill has been introduced for an appropriation of $250,000 to enable the Department of Agriculture to conduct experiments looking toward the discovery of a new motor fuel. Coal-tar products including benzol are under consideration as well as alcohol. That the expensive method of producing oil from the shale beds of Utah, Colorado, Wyoming, and Nevada is being more and more brought to the attention of investors, is an indication of the urgency of the oil situation. All this is occurring years earlier than should have been, owing once more to our lack of a definite policy of fuel conservation.

We formerly had no policy whatever in regard to utilization of the vast water powers of this country. The economic waste that existed under these conditions was such that we were eventually forced to adopt a definite policy, as illustrated in the recent Water Power Bill. This aims to protect the rights of future generations in this great natural resource.

Government Aid in Conservation

It is now the time to consider how the Government can assist in the conservation of coal and oil. It is the writer's personal opinion that coal and other natural fuels present a problem that so intimately concerns the welfare of all the people that it must equally concern the Government which represents the people, and that therefore until the general public through its Government takes action in the matter there can never be any truly adequate answer to this problem. The mere financial incentive to stop the unnecessary waste of fuel is not strong enough to do the job, for the reason that the great bulk of coal and other fuels is consumed in industrial undertakings, wherein substantial profits are readily available without the trouble of economizing in the application of fuel. This fact may be strikingly realized through the statement of an authority that of the total cost of all the manufactured products of the country only 2 per cent is fuel cost.

The public at large does not yet fully realize the importance of fuel as a national issue, but the writer believes that even now it is coming slowly into such a realization. Therefore, although the time is not yet ripe for any radical step in this direction, yet we may and must look forward ultimately to a solution along these lines.

The public must be made to see how adversely it is affected by this great and uncontrolled waste of fuel so that Government coöperation and assistance will be demanded. This means that time will be necessary in which to educate the public as to the importance of fuel conservation as a national issue in order to secure the necessary interest by Congress and Government bureaus.

Finally, the writer wishes to offer for consideration and constructive criticism the following policy of fuel conservation to be adopted with the coöperation of the Government:

(1) Regulation of quality of fuel.

(2) Measures for prevention of flagrant waste of all fuels.

(3) In the matter of transportation, zoning is productive of large economies.

(4) Better means of coal storage are urgently needed to flatten out load curves at the mines, which are now overcapitalized and overequipped 40 per cent.

(5) Possibilities of conservation by the United States Bureau of Mines.

(6) Great advantages to be secured by appointment of a resident engineer in each state, to keep in close touch with local industries and with a clearing house of information in Washington.

(7) A body of citizens advisory to Bureau of Mines should assist in the planning and development of the conservation program. It should be representative of business men, engineers, and citizens from various parts of the country.

(8) Correct design of new power plants, and perhaps changing of power equipment in existing power plants.

(9) Government should encourage new inventions and investigation, leading to the economical use of fuel.

(10) Better educational measures. Every technical school should have lecture courses on fuel conservation, more for the purpose of emphasizing its importance rather than from intensified and specific instruction. Educational courses for chief engineers and firemen. Examination for license in this profession. Provide throughout the country uniform examinations with corresponding certificates for operating engineers and firemen thus educated in steam and fuel and economics.

(11) Measures looking toward the development of low-temperature distillation of coal (and lignite) for the conservation of the immensely valuable by-products which at present are wasted when raw coal is burned for steam making. The resulting smokeless carbonized coal would then become the boiler fuel of the future in proportion to the extent to which this by-product industry could be economically developed.

FORM VALUE OF ENERGY IN RELATION TO ITS PRODUCTION, TRANSPORTATION, AND APPLICATION

By CHESTER G. GILBERT,[1] WASHINGTON, D. C., AND JOSEPH E. POGUE,[2] NEW YORK, N. Y.

COAL, oil,[3] and water power are the principal sources of energy in the United States. Although commonly regarded separately, they really constitute a single resource group which provides the energy essential to modern conditions and contributes commodities of growing importance besides. Two-thirds of the energy extracted is consumed as power in doing the work of industry and transportation, while the remainder is devoted to the production of heat and light, and the furtherance of chemical work. The commodity values held in coal and oil, while having an important and growing bearing upon modern needs, are largely ignored. Not only is the civic and industrial life of this country utterly dependent upon the energy materials, but the production, transportation, and distribution of these essentials constitute a prominent aspect of the country's activities.

Can this country continue to rely almost exclusively upon the railways for its supply of energy? Coal alone now engages nearly half the freight capacity of the railways. Can the cities and homes of the country afford to turn to bituminous coal with its smoke and dirt for their fuel dependency? Anthracite is fast becoming a luxury and metallurgical coke is not a satisfactory substitute. Is the public ready to curtail the use of automobiles and motor transport within the next few years because of an inadequacy of gasoline? The petroleum resource is already showing signs of strain. Is it wise for this country to ignore its water-power resources? Under present conditions water-power sites, with choice exceptions, cannot be developed. If we are prepared to answer these questions in the affirmative the whole matter may be dismissed. Otherwise, the present situation must come up for revision.

These are the most immediate points of practical contact with the energy problem. They all involve issues of the day: transportation, domestic fuel, motor fuel, water power. But these are not all. What of the congestion in our terminals and cities because of coal distribution and ash removal? What are the civic losses due to smoke? What of the values going to waste when raw coal is burned? Can these be saved and made to contribute to a lowered fuel cost? What are the chances of building up a large coal-products industry in this country? Has chemistry as yet wrested its full count from coal tar? What shall we miss by not cultivating this field? Can coal solve our nitrogen problem? What are the by-product possibilities in petroleum?

These questions are pressing forward for attention. They involve the foundations upon which our industrial stability, our domestic comfort, and our national welfare are based. With bountiful resource wealth and with mastery of technology we have proved ourselves to be lacking in adequate economic procedure to take advantage of our endowment. The conditions under which energy is brought into play in the United States are mainly an inheritance from a period when the character of energy resources was imperfectly known and the technology of energy employment was crudely developed.

The employment of our available resource in energy involves three progressive stages: production, transportation, and utilization. It may be of interest to examine coal, oil, and water power in turn with respect to their status under these headings.

Coal

The production of coal is scattered, uncoördinated, and wasteful. The coal mines of the country carry a variable but large idle capacity, accompanied by an uncertainty of operations, that is at once a menace to the stability of the labor supply and to the maintenance of an adequate output; the technique and practice of storing coal is imperfectly developed; the seasonal fluctuations in the demand for coal remain uncompensated. These conditions are essentially the product of past circumstances—excessive competition, overdevelopment of the resource, and inadequate prices at the mine mouth, which led to poor engineering and low recoveries of values.

Transportation is the weakest link in our coal supply. Coal forms over a third of the country's freight; the mining of coal is dependent upon an unbroken movement of coal cars past the mine mouths; the number of coal cars has never been equal to the full capacity of the developed coal mines. With every period of industrial prosperity, a car shortage is bound to result. Moreover, as a result of the size and industrial status of this country, the railways have a sufficient responsibility without the carriage of coal.

Present utilization of coal involves a very low recovery of the energy content and an almost total loss of the commodity values present. This of course necessitates the production, transportation, and distribution of a much larger quantity than would otherwise be required; concentrates the whole cost, in respect to the consumer, upon the modicum of energy extracted; requires the imports of materials which might be manufactured from the non-energy components; holds back the development of latent possibilities

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[3] In an economic sense, natural gas may be regarded as a variant of oil and needs no separate consideration in this summary paper, since the principles governing the production, transportation and utilization of both oil and natural gas are similar.

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in coal products; and besmears with dirt and smoke an untold wealth in civic improvements.

Petroleum

The production of petroleum involves a higher proportion of waste than is found in the mining of coal, with far more serious consequences because the domestic supply is altogether inadequate for meeting the present requirements of the country and the domestic resource is rapidly suffering depletion. Less than half of the oil underground is raised to the surface; there has long been an overproduction in respect to the higher types of uses, prompting the surplus to be used for crude purposes in the place of coal and water power.

The transportation of petroleum makes use of an extensive system of pipe lines, thousands of miles in length, spread over half of the country, connecting points of production with refineries, markets, and seaports. The efficiency attained in the transportation of petroleum energy is in marked contrast to that characteristic of coal energy, and should point the way to the reconstruction of the latter, whose faults are now throttling the commodity transportation of the country as well as contributing to unhealthy urbanization and sectionalization.

The utilization of petroleum is far in advance of coal in that the bulk of crude petroleum now produced is separated into its chief components—gasoline, kerosene, fuel oil, and lubricants—whereas coal is employed dominantly in the raw state. Here again the oil industry points to the analogous need for a coal-refining industry to separate coal into mobile forms of energy and commodities. The utilization of the various petroleum products displays various degrees of efficiency, with the greatest discount applying to the low-use products such as fuel oil. The by-product actualities held in petroleum are not yet adequately utilized, nor are the by-product potentialities sufficiently developed.

Water Power

Only a small fraction of the water-power resources of the country is developed. This is due to the abundance of coal and oil, on the one hand, and the high rate of interest demanded by capital in respect to hydroelectric developments, on the other, with complications growing out of public sentiment and legal restrictions regarding water-power rights under Federal control.

The transportation of hydroelectric power, so far as it is produced, is technically satisfactory. The lack of a common-carrier system for the transmission of electrical energy, however, contributes to the undevelopment of water-power sites by making it necessary for the generating project to provide its own transportation.

The utilization of electricity for power production and lighting has been more highly perfected than that of any other form of energy; the application of electricity has also been more efficiently developed than the production and transportation of this energy form, viewed in an economic sense. The status of electric application is a cause for congratulation in an energy situation fraught with shortcomings, but at the same time this development has exaggerated the lack of balance obtaining in the present state of development of the energy industry and invites further neglect of the other energy forms.

Technique of Energy Analysis

This brief review is sufficient to indicate that the various components of the energy situation have developed to different degrees of attainment, and with little relation of one to another. In an industrial age, energy, the basis of industry, has failed to become an integrated industry itself. The production of energy is still individualistic, corresponding to economic conditions of the past; industrial activities in general have evolved to an interlocking and coördinated whole; not so energy. With minor qualifications the field of energy has merely grown in size and the system of energy supply is now modern in proportions but ancient in structure.

The reconstruction of an economically and socially competent supply of energy is an issue of profound importance, which cannot be met by discordant attentions to its component parts. The greatest weakness in the present situation is the dissociated character of its growth; little can be accomplished by merely perfecting the subdivisions as they now stand. We are coming more and more to recognize the individual shortcomings, but the basis of the trouble is not generally sensed; our efforts toward betterment are themselves colored by the individualistic point of view and fall short of the mark.

The technique of conducting an adequate survey of the problem of energy supply involves a fundamental consideration of "form value" and "resource value." Form value is an intangible quality denoting the broad applicability of the energy form in contrast to its theoretical thermal value as ordinarily expressed in B.t.u., and involving the consideration of transportation as well as of utilization. Resource value is an intangible quality expressing the availability of energy in terms of location and chemical character of its source, and involving the potentiality of chemical control for purposes of multiple production.

Form Value

The concept of form value is of sufficient importance to warrant further attention. The significance of form value has been admirably illustrated by a series of valuable charts prepared by the W. S. Rockwell Company, covering industrial heating operations. The complete paper reproduces a member of this series, showing the factors governing the selection of fuel for industrial heating.

Comparative costs of the most commonly used forms of energy in terms of thermal value are also given in the complete paper and they clearly illustrate the fact that form value is of greater importance than thermal value as a decisive factor in energy selection, for otherwise no other form of energy could compete with bituminous coal and the chief elements of progress in energy supply thus far attained would be nullified. The importance of form value is so obvious that it is difficult to understand why it has been so universally neglected as a broad economic concept.

Form Value in Respect to Application

The applicability of energy involves not merely the utilization of energy, but the transportation of it as well; both considerations necessitate a coördinate view of the value of the energy form in respect to what the demand for energy requires. This concept leads to a study of form value relative to application as the initial step in the development of an energy supply.

As is well known, energy may be brought to the points of application in solid, liquid, gaseous, or non-substantial (electrical) form. Under each form there are varying degrees of energy concentration. The market for energy, as developed by the innumerable natural and artificial factors that have contributed to building the present range of requirements, demands all four forms in their numerous varieties.

Before we are in a position to consider adequately the transportation phase of the energy problem, therefore, we must first determine what will best serve the needs, having regard for the potentialities as well as the actualities, afforded not merely by one system of supply, such as the electrical, but by all other types as well. To impart a special impetus in any one direction is to retard developments in all others. We should bear in mind that expansion in any one form of energy automatically follows the development of appliances for transforming that energy into useful service and that electricity has outdistanced gas more by virtue of this fact than because of inherent superiorities.

The demand for energy is a composite of requirements varying regionally according to the prevailing industrial type, and locally according to the details of the application. Both regionally and locally considerable possibilities of correlation are present, especially as between the needs for industrial power, on the one hand, and the requirements for industrial and domestic heating, on the other; since the two types of demand are to a large degree complementary. On the whole, a difficult compromise will have to be reached between what the market at the moment desires, and what it may be educated to take.

Energy application in this country in point of development thus far is the composite result of promotion and advertising. We have electrical experts; powdered-coal enthusiasts; fuel-oil advocates; mechanical-stoker adherents; but no recognized court of appeal for an unbiased consideration of a given item. Detail

after detail of power or heating installation has been added to the country's total as a result of the particular hands to which the item happened to be assigned. The character of this development renders the quality of the demand singularly difficult of economic appraisal, since the point of view of the analysis itself is apt to be colored by the same historical precedence.

Form Value in Respect to Transportation

While the market is under appraisal, the transportation of energy will require consideration, since the form value with respect to application is not wholly independent of form value with respect to transportation, although the reverse relation is to a partial degree true. The energy market has thus far been dominated by the transportation facilities available, whereas there should be a give-and-take relation between the two.

The means for transporting energy, are, of course, cars for the solid and liquid forms, pipes for the liquid and gaseous forms, and wires for the electrical form. With these facilities in mind, an appraisal of energy transportation must have an eye both to the application of the energy at the points of use and the resource value at the points of origin. The prevalence of energy haulage in the solid form has not only reduced the efficiency of energy utilization but has lowered the resource value of the energy as well, not to mention the loss arising from competition with commodities in a congested railroad system. The means of transportation which have naturally developed, or which may be arbitrarily provided, should be studied not only with relation to the effect upon transportation itself, but with respect to their influence upon the efficiency which may be derived from the energy and the values which may be won from the resource. The transportation of energy by either pipes or wires tends to stimulate the enlargement of resource value through by-product recoveries, and the increase of form value through added efficiency in application. The proper balance between a system involving the use of cars, pipes, and wires is an ideal upon which sufficient information is lacking even to speculate, and chiefly because transportation has not been studied with due regard to form value and resource value.

Resource Value

Of the three major elements entering into the energy situation, resource value has suffered the greatest neglect, both by the circumstances of development as well as by current plans for reconstruction. One element of resource value—location—it is true has been overemphasized in the course of industrial development, with the result that we now have an unhealthy centralization and urbanization with an aggravation of sectional and class differences. The major element of resource value—chemical character—is only just now coming in for some degree of attention, although the interest in it is not usually carried through to the point where the interdependence of resource value, transportation, and form value becomes clearly illuminated. The chemical character of the resource raises the problem of chemical control for purposes of multiple production, in order that valuable materials occurring with the energy, as well as much of the energy itself, may be kept from going to waste. In other industries the only way in which advancing costs have been effectively met has been through multiple production and its better-known partner, mass production.[1] The main reason why energy prices have advanced so strongly is that in the absence of an energy industry there has been no chance for savings in these directions while producing costs have steadily increased. Energy will lose much in social potentiality if its resource value is not enhanced over that obtaining at the present time.

In fine, energy needs to be placed upon a sound industrial basis, and this requires that due consideration be given to all these factors that are studied as a matter of course in connection with the establishment and nature of a new industry. The need is for adjustments in energy form to the end that greater efficiency in utilization and transporation shall be obtained, and a full measure of resource value received.

[1] In an economic sense, mass production and multiple production are the same. Mass production is the mechanical equivalent of multiple production which involves the element of chemical control; in many industries the two become actually identical.

DISCUSSION AT FUEL SESSION

The oral discussion which followed the presentation of the papers on fuel was entered into by a large number, and that all might have an opportunity to express their views two adjourned sessions were necessary. One of these was held on Wednesday morning, the other on Thursday evening.

At the first session discussion was largely confined to Professor Breckenridge's paper on the Fuel Supply of the World, and that by David Moffat Myers on Fuel Conservation. The use of peat, oil shale, and coke as aids in fuel conservation was touched upon by many. George Otis Smith stated that in one area in western Colorado and in eastern Utah it has been estimated that there are about ten times as much shale as fluid petroleum. He also pointed out that the oil-shale industry could not be expected to develop as rapidly as the petroleum had done, as it involved a much larger expenditure per heat unit for human labor.

Edwin DeLany referred to a process of making fertilizer from peat and expressed the fear that the supply of peat would be used up long before it was in great demand as a fuel.

In connection with the coke industry, Frank H. Kneeland stated that while it requires the greatest coal consumption of any of the industries, it was possible, through the processes of distillation, to create a coal containing 35 per cent volatile and producing a residue of solid fuel containing 8 per cent volatile, which is practically the same as Pocahontas coal.

R. P. Bolton was the first to discuss the question from the standpoint of conservation. He referred to the saving made by shutting down small electric plants and using electrical energy from central stations. In one case, he stated, such procedure had resulted in a direct saving of 25,000 tons, and allowing for the coal used in the central station, a net saving of 15,100 tons.

H. M. Crane spoke at some length regarding the use of fuels in the automotive industry. He stated that the petroleum industry is attempting to obtain fuels suitable for small isolated plants and for use in automobiles. The conservation of such fuels, he declared, is dependent upon their proper use by the public.

Harrington Emerson confined his discussion to the saving to be effected by a study of locomotive fuels. The locomotives of the country, he stated, burn 140,000,000 tons of coal per year, and looking at railroads as concerns buying coal at wholesale and retailing it by the ton-mile and passenger-mile, they had lost, as a whole, during the year 1919 nearly $15 for every ton of fuel burned.

Horace C. Gardner called attention to the conservation to be effected by coöperation with the Government. The trouble, he said, was that we really have 49 governments and we must get the coöperation of all of them. He suggested that this was a problem for consideration by the newly created American Engineering Council.

Joseph Harrington was of the opinion that fuel conservation was a problem of applying the knowledge that we already have rather than attempting to develop new knowledge on the subject. He also stressed the importance of publicity and education.

W. C. Buell called attention to the fact that in the steel districts a great deal of work has been done on fuel conservation and that in one case of which he had knowledge a billet-heating furnace producing 70 tons per hr. was operated at a thermal efficiency of 60 to 63 per cent.

Gardner T. Voorhees discussed the question from the viewpoint of the large public-service and electric plants. He stated that a device might shortly be expected on the market which would take the heat from the steam which is now exhausted into the condenser and by using one pound of steam from the boiler furnish several pounds of steam at moderate pressure for heating purposes.

Prior to the adjournment of the morning session the chair announced that at a conference between the chairmen of the Professional Section on Power and the Professional Section on Fuel, it was decided that the activities of the Fuel Section should end in the steam pipes between the boiler and engine.

Discussion at the First Adjourned Session

At the first adjourned session discussion was opened by E. H. De Lany, who spoke of conservation and the possibilities of coöperation with the Government. Referring specifically to the con-

trol of the mines, he stated that the question involved was the right of the Government to interfere with what it considered the private property of the individual. The courts, he stated, have recently held that the Government has a right to control property in land which is in reality a franchise. In other words, every individual has some rights which he enjoys as different from other people and he also has rights which he enjoys in common with them.

C. S. Blake stated that conservation rested very largely with the owners of power plants and that it had been his experience since the war that many owners did not care to practice fuel economy. The country does not lack engineering skill to give advice in the economical use of fuel, he said, but the ratio of fuel cost to value of production was such a small percentage that it was hard to interest manufacturers in this much-needed economy. In order to bring about this conservation he urged that a system of education be carried on between The American Society of Mechanical Engineers and the fuel users and without Government force.

D. T. McLeod discussed the same question and at considerable length. Conservation, he said, should start at the mines, for present mining methods do not recover anything like the amount of coal that is possible. He also stressed the importance of conserving by-product coals. He concluded by relating some of his experiences with regard to operations at the mines, especially as to labor conditions and their effect upon production.

R. H. Kuss commented upon the need of information as to fuel economy. The Federal Government, he declared, was not prepared to give such assistance. A. G. Bailey also spoke of Government aid. We should have, he declared, every chamber of commerce helping to bring public opinion to bear on both city governments and public-service commissions.

R. P. Bolton referred to the great saving that could be made by conservation of the domestic supply. The heating of New York City, he said, involved the burning of 7,000,000 tons of coal a year. As a means of saving in the transportation of this coal he suggested that a system might be created by which the coal would be brought to the city through pipe lines similar to those in use in the oil industry. Two 14-in. pipes, he declared, should be sufficient.

H. H. Kimber spoke at some length regarding pulverized fuel and the many uses to which it has recently been put.

D. C. Buell offered two recommendations as to procedure for future meetings. The first of these was that the Society work out a form giving the proper value of the different items which an engineer must consider in studying the waste of fuel, and the second that the Society send a delegate to the annual meeting of the International Railway Fuel Association.

G. T. Pogue closed the discussion of the second session with the suggestion that the Fuel Section devote some attention to the economics of energy service.

Discussion at the Last Session

At the final adjourned session on Thursday evening E. H. De Lany opened the discussion by referring to the great need of educational work in fuel conservation, and said that in his opinion lectures on fuel conservation would be of great value. Loring Freed referred to the low-temperature carbonization of coal and suggested that the Society go on record as advocating a campaign of education to encourage the use of low-candle-power gas and low-B.t.u. gas.

George H. Sharpe, in discussing the division of work among the sub-committees that had been proposed to handle the question of fuel conservation, suggested that an engineering representative from the coal operators be placed on one of the sub-committees. If this were done, he said, he believed it might lead to the creation of plans whereby it would be possible to work the miners 250 or 275 days a year, with a resulting reduction in the cost of coal of somewhere between 30 and 35 per cent.

A. D. White suggested that a committee be appointed to formulate rules for the use of coal, similar to those now in use for the building of boilers. David Moffat Myers also commented upon what he termed " the code of conservation," and stated that while excellent results had been secured during the war by the use of a code of operation for power plants, we were now at peace and the problem is an entirely different one. He also referred to the system now employed for licensing of operating engineers and foremen and mentioned the desirability of instituting similar examinations for firemen. He concluded with the suggestion that when an industry is contemplating a change of equipment or the erection of a new plant, Government engineers should look over the plans and pass upon them so that they may conform to proper engineering economics and will not result in wasteful operation. The French Government, he stated, is doing this very thing.

George A. Orrok was of the opinion that the greatest offenders in the waste of coal are the householders who, he stated, waste 40 to 50 per cent of the coal they buy. The city of New York alone, he said, uses about seven million tons of coal annually for domestic purposes, and if some method could therefore be devised to educate the ordinary man in the use of coal, it would probably result in the saving of 30 to 40 million tons of coal every year.

Joseph F. Shadgen, speaking of conservation, stated that while education was exceedingly desirable, it was his experience that an appeal could best be made to a man by showing him that he was losing money. A. A. Adler said it was his belief that it would be impossible to educate the public into saving fuel by means of laws. He also spoke of the savings to be made by having houses properly designed and suggested that the architects be interested in the question of fuel economy.

E. Kilburn Scott referred to present methods of mining, and stated that he believed some commission should determine as to whether in the interest of economy the long-wall system could not be employed in this country much more than it is. In reference to Government coöperation for fuel economy, he urged that consideration be given to a closer coöperation with municipalities. In England, he stated, there is a conservation officer just as there is a health officer, and his job is to see that there is no waste and to issue printed matter to educate the public in the proper use of coal.

R. P. Bolton differed from the previous speaker and gave it as his opinion that the first class to be educated were Government officials and municipal authorities. He also referred to the question of economy in the individual homes of the people and stated that if the tenants in our large apartments had to pay for the steam they used, a very great difference in the amount of fuel burned would be seen.

M. S. Hutton suggested that if the newly formed Fuel Section should create a committee upon conservation, it should coöperate with the Federated American Engineering Societies, as under this larger organization any work that might be done would carry great prestige and weight.

F. R. Low told of the objections that were offered to the Boiler Code when it was first presented by the Society, and how little by little, as states began to adopt it, the owners of boilers had accepted it as a standard. This was so because boiler explosions were communal disasters. Similarly, he declared, the wilful and unnecessary waste of fuel is a communal loss. Fuel conservation he asserted, is a question of educating the individual and not of the passage of laws. "Cannot we impress these things upon the public," he said, "to an extent which will be fully as effective as a law which says 'Thou shalt not?'"

Elias Schlank closed the oral discussion by suggesting possible ways in which this education might be accomplished. Among other things he urged that the engineer take a larger part in civic affairs and that the children in the schools be taught the need and necessity of conservation.

Written Discussion

John W. Lieb, Jr., presented an extended discussion on the fuel problem in connection with the operation of public utilities, which use approximately ten to twelve per cent of the total bituminous production in this country. He said that whereas in 1916 the average price of good quality bituminous was roughly three dollars per ton f.o.b. tidewater, New York, of which about one-half was the charge for freight, at the present time the freight alone amounts to more than three dollars a ton. Apart from the price, however, it had been impossible during the past two or three years to obtain from coal operators a contract which, from a legal or commercial standpoint, is either reasonable or equitable. In fact, the "terms

and conditions" of the contracts, examples of which Mr. Lieb submitted, were such that they become at the pleasure of an unscrupulous operator practically a "scrap of paper," of little binding value.

Before the World War, said Mr. Lieb, there was sharp competition in the bituminous market and it is probably true that the competitive prices were too low and did not afford sufficient return on the investment. It was then possible to buy coal under a specification which assured its quality and would guarantee a certain number of B.t.u.'s per lb. within commercial limits, and a specified percentage of volatile matter, ash, degree of fusibility, etc. It was thus possible to gage boiler performance accurately and to obtain good boiler-room efficiency. All this has gone by the board. No specifications of any kind are obtainable at present. The boiler-room engineer cannot tell from one hour to the next what kind of coal is coming down on to the boiler-room floor or into the stoker hoppers. It has been a not infrequent experience to receive coal so deficient in quality that only 75 or 80 per cent of the maximum capacity of the boilers has been obtainable and station operators have been seriously concerned to meet the demands made upon them by their customers. Under these conditions, the speaker contended, the economic efficiency of utility plants (lb. of coal per kw-hr.) during the past two years cannot be taken as a fair or correct index of their normal and real economic efficiency.

Mr. Lieb then reviewed the history of the coal situation during the period of the war and subsequent to it, referring to the establishment of the Tidewater Coal Exchange, the restrictive orders under the Garfield Fuel Administration, the strike of bituminous coal miners in 1919, provisions for priority shipments, etc. He said that while the New York Edison Company had withdrawn from the New York Tidewater Exchange because it was unable through the Exchange to receive the specific coal which it had bought, the Exchange had been effective as a war measure. It had simplified railroad operation at the ports by having separate tracks for each pool classification and cars could be unloaded continuously without "drilling" out the cars of each individual shipper. But for the priority orders to the public utilities during August, September and until October 15, they would have met inevitable disaster and the country would have faced a national calamity.

Mr. Lieb then gave the following figures obtaining under the conditions prevailing during the period 1916–1920:

	1st 6 Mos. 1916	1st 6 Mos. 1920	Increase, per cent
Kilowatt-hours generated	322,750,850	422,070,915	30.8
Coal consumed, tons	289,289	438,834	51.7
Cost of coal (in bunkers) used	$921,331	$3,195,984	247.0

The pounds of coal per kilowatt-hour generated rose from about 2 lb. in the first six months of 1916 to $2^1/_3$ lb. the first six months of 1920, reaching as high a figure as 2.5 lb. for the second half of 1919, a decrease in efficiency of 25 per cent.

In the meanwhile the price had risen from approximately $3.20 per ton in the first half of 1916 to $7.30 per ton average for the first half of 1920; or, as expressed in cost of coal per kw-hr. at the generating-station switchboard, from 0.29 cent per kw-hr. to 0.76 cent per kw-hr., with a present cost of coal in the bunker of approximately $8.80 per ton and a coal cost of 0.9 cent per kw-hr. generated.

The question of storage of coal, Mr. Lieb said, might be regarded from two viewpoints: first, the endeavor to stabilize the output of the mines, make production more regular and uniform, and provide more continuous employment to the labor at the mines; and second, to protect the user against irregular deliveries due to unfavorable weather conditions, interference and delays in transportation, congestion at port terminals and harbor and switching difficulties. The former would call for storage at the mines, the latter, at the point of consumption.

The amount of storage necessary would depend on the size of a mine and the scarcity of cars, and car shortage had undoubtedly been the most serious of the difficulties encountered during the past year or two. Roughly, the average output of the mines is not over 50 per cent of their capacity, and, considering this caused entirely by lack of cars, it would appear that as the car shortages are rather daily than weekly or monthly, a bin storage capacity of 40 cars or approximately 2000 tons would be ample to take care of a 1000-ton mine. Taking the mean between the cost of wooden and concrete construction, the fixed charges on a 2000-ton pocket and machinery would amount to 7.5 cents per ton, which would be quite lost in consideration of the added output of 80,000 tons per year, and the more constant employment of labor with its enhanced efficiency.

The problem of storage at the point of consumption presented greater difficulties. It had been the experience of public utilities over many years that even in normal times it was necessary to provide for a reserve supply of fuel in storage to last from 45 to 60 days, dependent upon the proximity of the utility to its base of supply, its location on rail or water routes, dependency on one or more alternate transportation routes, rail or harbor terminal facilities, labor, barging, etc. On the limited areas usually available near large power plants this required the massing in piles of considerable height, introducing the difficult problems of protection against spontaneous combustion and the necessity of moving the coal in case of trouble. These contingencies, however, had to be met and the expense faced in order to safeguard continuity of operation.

It had been proposed that in order to stimulate the accumulation and storage of coal during the summer months when its transportation can be more easily accomplished, a lower freight rate be established during the season of favorable transportation conditions and a higher rate for the remainder of the year.

In conclusion, Mr. Lieb said that it would be seen that the problem of an adequate and regular supply of fuel to the public utilities was an important factor in our national economy, and that such a measure of practicable supervision and regulation of the production and distribution of the fuel supply to the railroads, army and navy, public utilities and public institutions should be assured as would secure to the public the guarantee of continuity of operation of these essential factors of modern civilization in the paramount public interest.

J. H. McNally. Since it is the intention of the Fuel Section to obtain, through coöperation, an exchange of ideas on the subject of fuels it is my theory that this coöperation should begin with the coal operator and not at the power plant. In seeking to coöperate with the various engineers in the power-plant field, we have great difficulty in ascertaining the kind and quality of coal that they desire, the usual saying being any low-ash, low-sulphur steam coal. As you know, this grade of coal is being very rapidly acquired by the metallurgical industries, so that in a short time none will be available for steam purposes, and it is my belief that a general educational campaign along the lines of utilizing our lower-grade coals, where fusion temperature and not sulphur is the index of the quality, would be very much in order.

Horace C. Porter. There is a confusion of statement and possibly of ideas as to the economic practicability of expansion in the industry of converting coal into coke, gas, and by-products. It is often assumed that this expansion would necessarily mean the displacing of raw coal for boiler fuel. As a matter of fact, however, coke and gas cannot compete with raw coal as a boiler fuel, even with the credit from the by-product ammonia, unless it be in large superpower stations, which sell the highest-grade coke and part of the by-products at prices well in excess of their relative B.t.u. values.

The abandonment in some measure of raw coal as boiler fuel may result from increasing use of centrally developed electric power from super-stations. Gas-fired boilers also may sometime prove to have lower overall costs than coal-fired, but the great field for expansion of coal carbonization lies in the other 35 to 40 per cent of our coal consumption not applied to steam raising. Beehive coking can and should be practically all displaced by recovery coking. The coal used in metal-heating and other industrial heating furnaces is probably 10 to 15 per cent of our total consumption. Gas and coke, or semi-coke, in the domestic field can be largely extended with profit, if the regulatory commissions will generally permit a B.t.u. standard for gas low enough so that manufacturing methods of highest thermal efficiency and therefore lowest costs can be used.

But for boiler firing, a much larger field, the problem is more

difficult, and the outlook less promising. The "thermal cost" of carbonizing ordinarily amounts to 15 to 20 per cent, and the total of operating and capital charges to 30 or 35 per cent of the cost of the coal. The returns from ammonia and light oils may amount to 15 per cent; accordingly the fuel products, coke, gas and tar, in order to pay for themselves, must have a practical value in application equal to 160 per cent of that of the coal, and this they do not have as boiler fuels in the present state of the art.

O. P. Hood. Mr. Myers points out many places where there is evident waste of coal and suggests that Government interest itself in the matter. Our machinery of government has developed through an effort to minimize these wastes of human imperfection, but comparatively little governmental machinery touches the waste of natural resources and the production of energy. In fact, it has been considered wisest to leave such matters as largely as possible to the interaction of individual effort. When, however, one realizes the national significance of serious waste, it is a natural thought to invoke the power of the state to police the situation. That the Government must help in the matter of energy conservation in order to protect its own life will sometime become evident to all the people and at that time many governmental agencies can be effectively employed to save coal. At the present time it is a question as to what extent the Government can interest itself effectively in this basic question. However, one perfectly safe method with which most everyone will agree is the use of educational methods which contain no element of compulsion.

It has been the opinion in the Bureau of Mines that perhaps the greatest need and the one on which attention should first be focused is that of providing machinery whereby the coal industry may be helped to maintain a reasonable standard of quality. The Bureau of Mines proposes a fuel-inspection system which contemplates as a salient feature advice to the public as to the quality of coal as shipped. The only force depended upon to produce results is a public statement of the facts, rather than the arbitrary police power needed in time of war. For this purpose the machinery for accurate sampling of full carload lots by an impartial organization is necessary. The Government now possesses facilities for analyses and publication.

It is proposed that each mining company set its own standard of quality, consistent with the particular vein, preparation, and market which the business affords, and that the government shall publish such standard and certify as to whether such standard is being maintained by the mining companies. Such work would not replace inspection by the mining companies. It would not certify as to the quality of each and every shipment, but it would inspect and sample at irregular intervals a sufficient number of cars of coal as shipped to indicate whether the declared standard of the mining company was being maintained.

It is believed that some measure of this kind, akin to our meat and wheat inspection system, fits the public temper at the present time and would be a real help in fuel conservation without going too far in governmental contact with business.

Walter N. Polakov. We have created public-service commissions and other governmental and official bodies to supervise the functioning of our public utilities. But so far as fuel consumption goes our gas works are using only about 1 per cent and our public-utility companies about 7 per cent of the coal, which is less than that annually destroyed by beehive coke ovens alone. Also the industrial steam trade consuming 33 per cent and the railroads, who are the greatest wasters, are allowed to continue to do so quite unmolested by public opinion.

During the war we created the Fuel Administration, but we were not consistent enough to carry out the good intentions to a true, logical conclusion by denying to the reckless and incompetent plants the privilege of wasting fuel. But even half-hearted measures to meet temporary expedients taught us a bitter lesson. We all have learned how easy it is for those who know to show how to prevent a goodly part of coal which we throw away and to secure which we keep thousands of men in mining and railroad industries doing utterly useless work. Patriotic motives being rapidly forgotten, the half-billion-dollar loss in fuel is cheerfully included in the cost of production of various commodities and now we have come to repent. Of course I do not mean to say that waste of coal by manufactur rs is alone responsible for high prices and dull times, but half a billion dollars included in the price of goods without increasing their value or usefulness in any way, is a matter to ponder about, both for consuming public and those manufacturers who are long-headed enough to see the handwriting on the wall.

Referring now to the paper by Messrs. Gilbert and Pogue, its exceptional value is due, in my estimation, to the fact that the authors clearly conceived and successfully applied to the solution of their problem all three forms of modern engineering: (1) technological, (2) economic and (3) social. Every industrial, creative problem must necessarily be studied from all these aspects, for otherwise the "abstract" engineering of a technician may prove to be either economically unsound or socially worthless.

The relative importance of form values in practice is usually obscured if not altogether disregarded because of wide divergence in economic advantages depending upon managerial ability of users of energy. Charts as prepared by Rockwell are theoretically interesting but practically misleading. Under poor management of the best-fitting and theoretically advantageous form energy it does often appear as wasteful. The electrical form of heating is inferior to gas or steam, but when management cares little as to methods of operation, electricity gives ultimately higher economy. Likewise fuel oil used under boilers is wrong from a broader economic aspect, but in practice coal is used so recklessly under either incompetent or disinterested management that fuel oil gains in popularity. In other words, the problem that must be solved in parallel with that pointed out by the authors is one of the immediate elimination of such wastes in power generation, distribution and utilization as now obscure the true significance of "form value" and stand in the way of both "integration of industry" and establishment of an "unbiased court of appeal," for otherwise its consideration will be distorted by wide variations in the degree of managerial efficiency in employing different sources of power.

G. H. Sharpe. Before the war, coal organizations, confining myself particularly to the Eastern bituminous field, started their selling organizations about April 1st, the recognized beginning of the coal year, and vigorously solicited contracts for the delivery of coal over the twelve future months. Purchasing agents for industries and railroads, however, studiously refused to enter into contracts providing for a regular flow of coal during the months of April, May, June and July, and in many cases, August, thus crowding the major portion of their demands into the months of September to March, inclusive, with all the attendant handicaps of difficulties in transportation and lowered output per miner during the winter season.

The coal operator found no reasonable market for his output during these dull months and knowing the expenses of a shutdown, turned to the middleman or broker, and he in turn drove a hard bargain for the delivery of a fixed tonnage per month over the year.

This practice has built up a brokerage class who are much wiser than the purchasing class in coal distribution and much stronger financially than the larger percentage of operators, and they have simply seized the opportunity that has been afforded them during the past year.

As engineers it is our duty to aid in the education of the coal consumers. They must buy and store coal every month in the year and they must buy and store a greater tonnage from April to September, inclusive, than during the remainder of the coal year. The larger public utilities are, as a rule, consistent in their coal purchases, but the greater number of small public-utility plants are dilatory, so that in the end all must suffer equally for the Fabian tactics of the majority. Some of the public utilities, however, are able to pass the additional cost along to the public, who, after all, are in a great measure responsible for the conditions.

Charles C. Phelps. Many engineers have no opportunity for saving fuel except in the particular plants with which they are connected. Hence it is of interest to have data for comparing results obtained in different plants. An article by David Brownlie published recently in the *Chemical Trade Journal and Chemical Engineer* gives interesting figures representative of British boiler plants. In an investigation of 250 miscellaneous plants and of 60 chemical plants, tests representative of everyday operation and

(*Continued on page 38*)

Power Test Codes

A.S.M.E. Committee Appointed to Formulate a Test Code for Reciprocating Steam Engines, Submits the Preliminary Draft Given Below

IN 1918 the Power Test Committee of the A.S.M.E. was reorganized to devise and enlarge the Power Test Codes of the Society, published in 1915. The Committee is a large one, under the chairmanship of Fred R. Low, and under its direction are 19 individual committees of specialists who are drafting codes for the different classes of apparatus comprised in power-plant equipment. Below is reproduced the second of these codes to be completed, namely, the Test Code on Reciprocating Steam Engines. This Code was prepared by a committee consisting of William C. Brown, Chairman, Alexander G. Christie, Secretary, George H. Barrus, Harte Cooke, Herman Diederichs, J. F. Max Patitz, and Fred H. Vose.

This Committee will, of course, welcome suggestions for corrections or additions. These should be mailed before February 1 to the Chairman, care of The American Society of Mechanical Engineers.

Test Code on Reciprocating Steam Engines

Introduction

1 The code for steam-engine tests applies to tests for determining the performance of the engine alone (including reheaters and jackets, if any), apart from that of the independently driven auxiliaries which are necessary for its operation, and apart from that of feedwater heaters or other apparatus for reclaiming heat. For tests of an engine and independently driven auxiliaries combined with means for reclaiming heat (for example, a multiple-expansion engine from the receiver of which steam is withdrawn for heating feedwater or other purposes), the rules given in the Code for Complete Steam Power Plants should be followed.

Object

2 In accordance with the "General Instructions" the object of the test should be determined and recorded. If the object relates to the fulfillment of a contract-guarantee, an agreement should be made before the test between the interested parties concerning all matters about which dispute may arise, as noted in Par. 3 of the "General Instructions," and the points agreed upon should be stated in the Report of the Test.

Measurements

3 The measurements that must be made in a performance test of a reciprocating engine will consist of some or all of the following quantities:

(*a*) The cylinder diameters and stroke
(*b*) The volumetric clearance in per cent of the piston displacement
(*c*) The diameters of piston rods and tail rods
(*d*) The indicated horsepower
(*e*) The brake horsepower or shaft horsepower output
(*f*) The kilowatt output if engine is connected to a generator
(*g*) The speed in revolutions per minute
(*h*) The pressure in the steam pipe before the throttle
(*i*) The barometric pressure
(*j*) The percentage of moisture or number of degrees of superheat in the steam just before the throttle
(*k*) The back pressure in the exhaust pipe near the engine cylinder
(*l*) The receiver pressure
(*m*) The temperature of the exhaust steam leaving all cylinders
(*n*) The temperature of the drips if any, from jackets, reheaters and receivers.
(*o*) The temperature of steam leaving receivers, cylinder jackets, reheaters and similar parts
(*p*) The weight of return drips from jackets, reheaters and receivers
(*q*) The weight of the condensed steam in pounds or the weight of the water fed to boilers, less drips and leakage if the test is based on feedwater fed to boilers, less drips and leakage if the test is based on feedwater measurement
(*r*) The temperature of the condensed steam
(*s*) Engine-room temperature and outside air temperature
(*t*) The variation in steam pressure in the steam chest.

Instruments and Apparatus

4 The instruments and apparatus required for a performance test of a reciprocating steam engine are:

(*a*) Tanks and platform scales for weighing water (or water meters calibrated in place)
(*b*) Graduated scales attached to the water glasses of the boilers if the feedwater is measured
(*c*) Pressure gages, vacuum gages or mercury columns and thermometers
(*d*) Steam calorimeters
(*e*) Barometer
(*f*) Steam-engine indicators
(*g*) Planimeter
(*h*) Tachometer, revolution counter or other speed-measuring apparatus
(*i*) Friction brake or dynamometer, if available
(*j*) Appropriate electrical instruments if engine is connected to an electric generator.

Directions regarding the application, use, and calibration of these instruments and apparatus and statements as to their accuracy are given in Pars. Nos. ——— of the Code on Instruments and Apparatus.

Preparations

5 Before proceeding with an engine test Pars. 4 to 8 of the "General Instructions" should be carefully studied. The dimensions and the physical condition not only of the engine but of all associated parts of the plant essential to the object of the tests, should be determined and carefully recorded. The following paragraphs suggest methods by which this information may be secured if required.

Dimensions

5a The dimensions of engine cylinders should be taken when they are cold. If extreme accuracy is desired as in scientific investigations, corrections should be applied to the cold dimensions to conform to the mean working temperature. If the cylinders are much worn, the average diameter should be found. The clearance of the cylinders may be determined approximately from working drawings of the engine. For accurate work, when practicable, the clearance should be determined by the water-measurement method. To carry out this method, set the engine exactly on the center, with the piston at the end of the cylinder where the clearance is to be determined. From a quantity of water previously weighed pour enough into the clearance space by means of a funnel through some available opening, such as may be obtained by removing a steam valve in a horizontal four-valve cylinder, or through indicator cocks, until the clearance space is completely filled. By weighing the water remaining the amount necessary to fill the clearance space can be obtained, and by making the proper allowance for temperature the clearance volume may be calculated. The percentage of clearance is found by dividing the clearance volume thus found in cubic inches by the volume displaced by the piston in one stroke, also in cubic inches. Care should be taken to see whether the clearance space is so arranged that no air is retained when it is filled with water. If such pockets cannot be properly vented, this method will not give accurate results. When full, the gradual lowering of the water will show leakage by the valves or piston. Allow leakage to go on for a certain time, then from a quantity of water previously weighed pour enough into the clearance space to fill it up again, note the time it takes to do this and weigh the water remaining after filling up the clearance space. Then the weight of water from which clearance space is to be calculated (W_1) can be determined as follows:

$$W_1 = W - \frac{wT}{t - t_1}$$

Where W = weight of water filled into clearance space.
T = time to fill clearance space
t = time allowed for leakage
w = weight of water for filling space up again
t_1 = time required to fill clearance space again.

This method will give the proper correction to be subtracted if the leakage is not very great. If the leakage is too great, and the object of the test will allow it, the valves and piston rings must be put in proper condition.

The area of interior steam surfaces is all of that part of the interior of the steam cylinder, the piston head and the parts back to the valves that are exposed to the steam at the time that the exhaust valve is opened. If desired, the clearance surfaces can be calculated by subtracting from this interior steam surface the area of the circumferential walls of the cylinder from the location of the piston at the dead-end center to the location of the piston when the exhaust valve first opens.

Leakage Tests

5b To determine whether the leakage of an engine is excessive or nominal, it should be weighed. This can be done in the following manner: In the case of a single-cylinder four-valve engine with a surface condenser, a cover or handhole plate on the bottom of the condenser is removed or a drip is tapped in the bottom of the condenser shell and, after turning on the circulating water, steam is allowed to pass into condenser until the condensate flows out of the opening in the bottom. Then the steam is turned off the engine and careful note is taken whether or not the flow of water stops, thereby testing the tightness of the condenser. (See Par. 6a for method of testing condensers for tightness when measuring condensate.) The engine should then be blocked just beyond the head-end center, with the valves in mid-position with full steam lap, the throttle opened and the leakage weighed for each minute for fifteen minutes or a half-hour, thereby determining the rate. This operation should be repeated with the engine just beyond the crank-end center. Each of these tests gives the leakage by one steam valve, one exhaust valve and the piston. If the leakage is only nominal no further leakage tests need be made, but if the leakage is excessive its source should be determined. In any case it cannot be assumed that such tests give an exact measurement of the leakage under operating conditions. They merely indicate the degree of leakage.

5c In testing for the degree of leakage in the high-pressure cylinder of a compound engine the exhaust valves of the low-pressure cylinder, or the relief valves if they are connected to the condenser, should be opened to allow the leakage to pass. The low-pressure cylinder may be tested like that of a single-cylinder engine by admitting steam to it through the receiver and by-pass valve. Care should be taken when thus testing a compound engine that the pressure differences applied in both cylinders are approximately the same as the working pressure differences.

5d If the engine has no surface condenser, a small one can be fitted up, or the leakage condensed by letting it flow into a barrel of cold water. If the engine is reasonably tight it may be assumed that the leakage should not exceed one-tenth of a pound per rated horsepower per hour, or one per cent of full-load steam consumption, so that the capacity of the small condenser or barrel of cold water need not exceed this amount.

5e A method of testing for the degree of leakage of valves and pistons by observation in a four-valve engine, or an engine in which the admission valves can be worked by hand independently of the exhaust valves, is as follows: The engine is turned until the piston is about mid-stroke. The two steam valves are closed, the two indicator cocks are opened, and the full pressure of steam is admitted into the chest by opening the throttle valve. The starting bar is then moved first one way and then the other, closing first one and then the other exhaust valve, and the degree of leakage by the steam valves can be roughly judged by the force of the steam coming out of the indicator cocks. To test the exhaust valves and piston, the flywheel is blocked so that the piston will be at a short distance from the end of the stroke, and the steam is turned on. The leakage then escapes to the exhaust pipe, and can be observed at the open atmosphere outlet. If the outlet is not visible and there is a valve in the exhaust pipe, this can be shut and the indicator cock on the opposite end of the cylinder opened, thereby diverting the steam which leaks and causing it to appear at the indicator cock. In a condensing engine where no atmospheric exhaust is provided, and where there is no opening that can be made in the exhaust pipe between the engine and the condenser, some idea can be obtained in regard to the amount of leakage by observing how rapidly the condenser is heated. It is well to make these tests with the piston in different positions, so as to cover the whole range of the length of the stroke.

5f Another method of testing for the degree of leakage is called the "time method." Instead of observing the steam that actually blows past the valves or piston to be tested, they are subjected to full steam pressure, and when the parts are thoroughly heated, the throttle valve is shut and the length of time which is required for the pressure to disappear is observed. In testing the piston and exhaust valves, the flywheel is blocked as before, and, preferably, an indicator is attached, and lines drawn on a blank card at intervals of, say, one-quarter of a minute after the valve is shut, thereby making a record of the fall of the pressure. In a tight engine the fall of the pressure is slow, whereas in a leaky engine it is sometimes very rapid. The relative condition of the engine under test as compared with a tight engine must be judged by the observer, who must, of course, have had experience in tests of this kind on engines in various conditions. The leakage of a piston may be determined by removing the cylinder head, after first blocking the engine, and observing what blows through the open end with the pressure of steam behind it. The advantage of the time-method is that it saves the labor and time required in removing the cylinder head and replacing it, which, in the case of large engines, is considerable.

5g Leakage tests of single-valve engines cannot be made as satisfactorily as those of the four-valve type. The best that can be done as regards the valve is to place it at or near the center of its travel, covering both ports, and then make the test under full pressure. The valve and piston can be tested as a whole by blocking the flywheel and opening the throttle valve in the same way as in the other engines.

5h In testing compound engines for the degree of leakage the work is somewhat simplified, as compared with a simple engine. For example, leakage of the high-pressure cylinder can be revealed by opening the indicator cock on the proper end of the low-pressure cylinder, the steam valve of that cylinder being open. The test of leakage of the low-pressure exhaust valve and piston when the time method is used may be based on the indication of the receiver gage, instead of using an indicator. In that case the fall of the pressure due to leakage is read directly from the gage.

5i In four-valve engines the degree of leakage of the piston with the engine in operation can be observed by removing the cylinder head, disconnecting the steam and exhaust valves at the head end, and setting the engine to work with steam admitted at the crank end only.

5j Referring to leakages that vitally affect the accuracy of a test, it is not always necessary to blank off a connecting pipe to make sure that there is no leakage through it. If satisfactory assurance can be had that there is no chance for leakage, this is sufficient. For example, where a straight-way valve is used for cutting off a connecting pipe, and this valve has double seats with a hole in the bottom between them, this being provided with a plug or pet cock, assurance of the tightness of the valve when closed can be had by removing the plug or opening the cock. Likewise, if there is an open drip pipe attached to an unused or empty section of pipe beyond the valve, the fact that no water escapes here is sufficient evidence of the tightness of the valve. The main thing is to have positive evidence in regard to the tightness of the connections, such as may be obtained by the means suggested above. But where no positive evidence can be obtained, or where the leakage that occurs cannot be measured, it is of the utmost importance that the connections should be broken and blanked off. Leakage of relief valves which are not tight, drips from traps, separators, etc., and leakage of tubes in the feedwater heater must all be guarded against or measured and allowed for. It is well as an additional precaution to test the tightness of the feedwater pipes and apparatus concerned in the measurement of the water by shutting the feed valves at the boilers, making sure that they are tight, and turning steam on to the feed pump. If there is no leak the pump can run only as fast as is permitted by its own slippage. Leakage will be revealed by disappearance of water from the supply tank. A gage should be placed on the pump discharge to guard against undue or dangerous pressure.

5k To determine the leakage of steam and water from boiler, steam pipes, etc., up to engine throttle valve, the water-glass method may be satisfactorily employed. This consists of shutting off all the feed valves (which must be known to be tight), including the main feed valve, thereby stopping absolutely the entrance or exit of water through the feed pipes to or from the boiler; then maintaining the steam pressure in boiler and steam lines (by means of a very slow fire) up to a fixed point, which is approximately that of the working pressure, and observing the rate at which the water falls in the gage glasses. It is well, in this test, as in other work of this character, to make observations every ten minutes, and to continue them for such length of time that the differences between successive readings become constant. In many cases the conditions will have become constant at the expiration of fifteen minutes from the time of shutting the valves. In boilers with much brickwork, especially if run at a high rate, it will be several hours before pressure conditions become constant and safety valves stop popping. Thereafter the fall of the water level due to leakage of steam and water becomes approximately constant. It is usually sufficient, after this time, to continue the test for two hours, thereby obtaining a number of half-hourly periods. When this test is finished, the quantity of leakage is ascertained by calculating the volume of water which has disappeared, using the area at the water level and the depth shown on the glass, and multiplying by the weight of one cubic foot of water at the temperature observed. The water columns should not be blown down during the time a water-glass test is going on, nor for a period of at least one hour before it begins. If there is opportunity for condensation to occur and collect in the steam pipe during the leakage test, the quantity should be determined as closely as possible and properly allowed for.

6 *Steam Consumption.* The steam consumption of an engine equipped with a surface condenser should be determined by measuring the condensate from the condenser, assurance being obtained that all the steam entering the cylinders passes into the condenser. If the condenser leaks, the defects causing the leaks should be remedied or suitable corrections should be made. The water of condensation from jackets and heaters, if not included in the condensate, should be weighed separately and added thereto. If a surface condenser is not available, the steam consumption should be determined by feedwater tests, which require the measurement of the various supplies of water fed to the boiler, of the water wasted by separators and drips on the main steam line, of the steam used for other purposes than the main engine cylinders, and of water and steam which escape by leakage from the boiler and piping. All of these last quantities must be determined and be deducted from the total measured feedwater supplied to the boiler. The heat consumption is determined from the steam consumption as pointed out in Par. 12.

6a In making an engine test where the steam consumption is determined from the amount of water discharged from a surface condenser, leakage of the piston rods and valve rods should be guarded against; for if this is excessive, the test is of little use, as the leakage consists partly of steam that has already done work in the cylinder and partly of water condensed from the steam in contact with the cylinder. Leakage of the condenser itself may be determined by operating the condenser under vacuum when all steam from the engine is shut off, and observing the rate at which the water, if any, is discharged by the condensate pump. When salt water is used for circulating water, leakage may be determined by testing the condensate with silver nitrate or by some other suitable method such as the conductivity bridge or the Dionic tester. If a few drops of solution of silver nitrate added to a sample of condensate produce a white precipitate, the presence of salt water is indicated.

6b When no other method is available, the steam consumption may be determined approximately by the use of a steam meter calibrated under the conditions of use.

6c The steam consumed by independently driven auxiliaries which are required for the operation of the engines should not be included in the total steam from which the steam consumption is calculated. These should be supplied from a separate boiler, if possible, if the steam consumption is determined by the measurement of feedwater.

6d The steam consumption of auxiliaries may be determined approximately by the water-glass test, as described in Par. 5k.

Operating Conditions

7 The operating conditions conforming to the object in view should prevail throughout the trial, as pointed out in Par. 19, of the "General Instructions."

Starting and Stopping

8 The engine and appurtenances should first be thoroughly heated and run under the prescribed conditions until uniformity is secured. If the period to be covered by the test includes the time employed in warming up a cold engine, as in the practice of many industrial plants, the preliminary heating should be omitted, and the conditions should all conform to the usual operations.

8a When a surface condenser is used, the test should start by commencing to weigh or measure the condensate and any other quantities of steam consumption involved, at the same time beginning the regular observations and other necessary test work. At the end of the allotted time the test is stopped by discontinuing the measurements and observations. When feedwater measurements are employed, the test should be started by carefully observing the steam pressure and water level in the boiler, and the level in the feed tank, if measuring tanks are used, at the same time beginning the water measurements and taking up the regular work of the test. At the end of the prescribed time, the water levels and steam pressure should be brought as near as practicable to the same points as at the start, and the observations discontinued. If there are differences in the water levels or pressure, proper corrections must be applied to the water measurements.

8b When feedwater measurements are employed care should be taken in cases where the activity of combustion affects the height of water, that the same conditions of fire and draft are secured at the end as at the beginning. Care should also be observed to note the average height of water in the glass when the water line fluctuates.

Duration

9 When surface-condenser measurement is employed and the load is substantially constant, the test should be continued for such time as may be necessary to obtain a number (not less than three) of successive half-hourly records during which the results are reasonably uniform. When the steam consumption is determined by measuring the feedwater supplied to the boiler, the run should be as long as the operating conditions permit. For accurate results the duration of such a test should be at least five hours.

9a When the conditions determined upon are such that the load varies widely at different times, the duration should be such as to cover at least the entire period of variation.

Records

10 The general data should be recorded as pointed out in Pars. 20 to 30 of the "General Instructions." Instruments should be read and indicator cards taken from each end of each cylinder at least quarter-hourly when the conditions are uniform and oftener when there is much variation. If there are wide fluctuations in readings they should be shown by recording instruments. Each indicator card should be marked with the number, date, time, scale of spring and end of cylinder, and on one card of each set the readings of the steam gages should be recorded. The log should contain the record of the readings of steam and vacuum gages, thermometers, calorimeters, speed indicator, load-measuring devices, and all other instruments, and these readings should be obtained at practically the same time the indicator cards are taken. The areas, lengths, mean effective pressures, and cut-offs shown by the indicator cards, should also be entered in the log. If complete test data are desired, representative steam-pipe diagrams should be taken with an indicator applied near the throttle-valve gage and operated by connection to the reducing motion of the cylinder indicators.

10b A set of specimen indicator diagrams should be carefully selected from the whole number taken, and these should be embodied in the record. The specimen cards selected should be such as to show the average conditions of pressure and cut-off. If steam-pipe diagrams are obtained, specimens of these should also be placed in the record.

Calculation of Results

11 *Steam Consumption.* Whether the engine is supplied with wet, dry and saturated, or superheated steam, the actual steam consumption is stated in the report of the test. When the engine is supplied with wet steam, the quantity of dry and saturated steam comprised in the wet steam is found by deducting from the total weight of steam as measured the moisture as shown by a calorimeter near the throttle. Superheated steam requires no correction. The "equivalent steam" consumed corresponding to any desired or specified set of conditions as to moisture, superheat, pressure, and vacuum which differ from the conditions of the test —such, for example, as those required by a contract guarantee or acceptance test—should be determined in the manner previously agreed upon by the interested parties in accordance with Par. 3 of the "General Instructions." (See Code on Definitions and Values, Par. 93.)

11a In view of the fact that "dry saturated steam" is practically unobtainable commercially and that the presence of moisture is detrimental to the economy of the engine to a greater degree than the amount present in the steam would indicate, arbitrary corrections (referred to in Par. 11 above) for correcting the actual steam consumption for quality are to be used in arriving at a value of "Equivalent Steam."

12 *Heat Consumption.* The number of heat units consumed by an engine per hour is found by multiplying the consumption, as measured in pounds of steam per hour, by the difference between the total heat in one pound of steam at the average pressure and of the average quality found in the steam pipe near the throttle and the heat in one pound of water at the temperature of saturated steam at the average pressure existing in the exhaust pipe near the cylinder.

13 *Indicated Horsepower.* The indicated horsepower for each end of the cylinder is found by using the formula

$$\text{I.hp.} = \frac{P\,L\,A\,N}{33{,}000}$$

where P represents the mean effective pressure in pounds per square inch, L the length of the stroke in feet, A the area in square inches of the piston less the area of the piston rod, if any, and N the number of revolutions per minute. The total horsepower of the cylinder is the sum of the horsepower developed in the two ends.

13a The mean effective pressure should be found by dividing the area of the diagram in square inches as determined with a correct planimeter, by the length of the diagram in inches, and multiplying the quotient by the average corrected scale of the indicator spring. If a planimeter is not available, the approximate mean effective pressure may be determined by finding the average height of the diagram in inches as obtained by averaging a suitable number of ordinates, at least ten, measured between the lines of the forward and return strokes, and then multiplying this average by the scale of the spring.

14 *Brake Horsepower.* The brake horsepower is found by multiplying the net pressure or force W in pounds on the brake arm —that is, the gross pressure minus the weight when the brake is entirely free from the pulley—by the circumference of the circle whose radius is the horizontal distance L in feet between the center of the shaft and the bearing point at the end of the brake arm, and by N the number of revolutions of the brake shaft per minute, and dividing the final product by 33,000.

$$\text{B.hp.} = \frac{2\,\pi\,LWN}{33{,}000}$$

See Code on Instruments and Apparatus for descriptions and methods of applying brakes.

15 *Electrical Horsepower.* The electrical horsepower of a generator is found by dividing the output at the terminals expressed in kilowatts by the constant 0.7457. In the case of an alternating-current generator the quantity of output determined, whether expressed in electrical horsepower or kilowatts, should be the net output. When the power for excitation or ventilation is taken directly from the engine shaft, the net output is that indicated at the a.c. generator terminals. When this power is taken from the a.c. generator through a motor or from some outside source, the net output is found by deducting the current furnished as excitation from that indicated at the terminals.

16 *Thermal Efficiency.* The proportion of the total heat consumption which is converted into work is called the "thermal

efficiency," and is found by dividing 2547 (B.t.u. equivalent to 1 hp-hr.) by the number of heat units actually consumed per hp-hr. (Par. 12). The quotient is multiplied by 100 to express the thermal efficiency in per cent. The formula is

$$\text{Thermal Efficiency} = \frac{2547}{w\,(H_1 - q_2)}$$

where w = pounds of steam as supplied per i.hp-hr.
H_1 = total heat above 32 deg. per pound of steam at the initial conditions prevailing before throttle valve.
q_2 = heat of liquid above 32 deg. in one pound of water at the temperature of saturated steam at exhaust pressure.

17 *Engine Efficiency.* The engine efficiency is the ratio obtained by dividing the heat equivalent of the actual work done by the heat available for an ideal engine. The accepted standard for the ideal steam engine is the Rankine cycle (Code on Definitions and Values, Par. 89). The engine efficiency is obtained by the following equation:

$$\text{Engine Efficiency (referred to i.hp.)} = \frac{2547}{w\,(H_1 - H_2)}$$

where w = pounds of steam per i.hp-hr.
H_1 = total heat above 32 deg. per pound of steam at the initial conditions prevailing before the throttle valve
H_2 = total heat above 32 deg. per pound of steam after adiabatic expansion from initial conditions to the final pressure.

H_1 and H_2 can be found from any Total Heat-Entropy diagram. $(H_1 - H_2)$ is the heat available for work.

18 *Nominal Cut-Off.* The nominal cut-off can be found in the following manner from an indicator card: Through the point of maximum pressure during admission a line is drawn parallel to the atmosphere line. Then through a point near the top of the expansion line where the cut-off is complete, a hyperbolic curve is drawn. The intersection of these two lines is the point of nominal cut-off, and the proportion of cut-off is found by dividing the length measured on the diagram up to this point by the total length, as shown in Fig. 1.

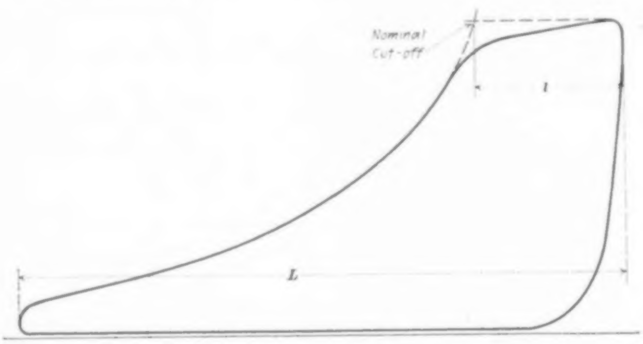

FIG. 1

NOTE.—The method of calculating the steam accounted for by the indicator card has been omitted for the following reasons:
(*a*) It is not essential to a performance test of an engine;
(*b*) As this method does not even approximate the actual steam consumption of an engine, it is liable to be misleading unless thoroughly understood.

19 *Throttle Pressure.* The throttle pressure, or the average pressure in the steam pipe just before the throttle, is that shown by a corrected steam gage attached at the desired point, the fluctuations of which are reduced so far as may be by choking the gage cock. When extreme accuracy is desired or when the fluctuations are large the average pressure may be found by working up the steam-pipe diagram taken at or near the same point and finding the mean pressure for the entire stroke, during the periods of admission. The superheat or quality of the steam supplied should be measured in the steam supply pipe before the throttle valve.

19a In the case of guarantee tests of capacity, if so agreed upon, the throttle pressure may be taken as the minimum pressure shown on an indicator diagram taken from the steam pipe near the throttle.

DATA AND RESULTS

20 The data and results should be reported in accordance with the form (Table 1) given herewith, adding lines for data not provided for, or omitting those not required, as may conform to the object in view. If the principal data and results pertaining to steam consumption only are desired, the subjoined abbreviated table (Table 2) may be used. Unless otherwise indicated, the items should be the averages of all observations.

See Note 1 of Table 1 for references to engines driving electric generators and other machinery.

TABLE 1 DATA AND RESULTS OF RECIPROCATING STEAM-ENGINE TEST

(A.S.M.E. Code of 1920; Long Test)

GENERAL INFORMATION

(1) Date of test ....
(2) Location ....
(3) Owner ....
(4) Builder ....
(5) Test conducted by ....
(6) Object of test ....

DESCRIPTION, DIMENSIONS, ETC.

(7) Type of engine (simple or multiple expansion) ....
(8) Class of service (mill, marine, electric, etc.) ....
(9) Auxiliaries (steam or electric drive) ....
(10) Type and make of condenser equipment ....
(11) Rated capacity of condenser equipment ....
(12) Type of oil pump, jacket pump, and reheater pump (direct or independently driven) ....
(13) Rated power of engine ....
(14) Kind of valves ....
(15) Type of governor ....

First Second Third

(16) Diameter of cylinders .... in. ... in. ... in.
(*a*) Diameter of piston and tail rods .... in. ... in. ... in.
(17) Stroke of pistons .... in. ... in. ... in.
(18) Clearance volume in per cent of piston displacement ....
(*a*) Clearance head end .... in. ... in. ... in.
(*b*) " crank end .... in. ... in. ... in.
(*c*) " average .... in. ... in. ... in.
(19) Head end hp. constant (stroke × net piston area ÷ 33000) ....
(20) Crank end hp. constant (stroke × net piston area ÷ 33000) ....
(21) Cylinder ratio (based on net piston displacement), 1 to ....
(22) Area of interior steam surface .... sq. ft.
(23) Area of jacketed surfaces .... sq. ft.
(24) Capacity of generator or other apparatus consuming power of engine .... hp. or kw.

TEST DATA AND RESULTS

(25) Duration of test .... hr.

Average pressures

(26) Barometric pressure .... in. of mercury .... lb. per sq. in.
(27) Pressure in steam pipe near throttle by gage .... lb. per sq. in.
(*a*) Corresponding absolute pressure .... lb. per sq. in.
(*b*) Minimum pressure above atmosphere, steam-pipe diagram near throttle .... lb. per sq. in.
(*c*) Minimum pressure above atmosphere, steam-pipe diagram near throttle .... lb. per sq. in.
(28) Pressure in 1st receiver, by gage .... lb. per sq. in.
Corresponding absolute pressure .... lb. per sq. in.
(29) Pressure in 2nd receiver, by gage .... lb. per sq. in.
Corresponding absolute pressure .... lb. per sq. in.
(30) Pressure or vacuum in exhaust pipe near engine by mercury column .... in of mercury
(*a*) Corresponding absolute pressure .... lb. per sq. in.
(31) Pressure in jackets and reheaters .... lb. per sq. in.

Temperatures

(32) Engine-room temperature .... deg. fahr.
(33) Temperature of steam near throttle .... deg. fahr.
(34) Temperature of saturated steam at throttle pressure .. deg. fahr.
(35) Temperature of steam if superheated:
(*a*) Entering 1st receiver .... deg. fahr.
(*b*) Leaving 1st receiver .... deg. fahr.
(36) Temperature of steam if superheated:
(*a*) Entering 2nd receiver .... deg. fahr.
(*b*) Leaving 2nd receiver .... deg. fahr.
(37) Temperature of saturated steam corresponding to pressure in exhaust pipe near engine .... deg. fahr.
(38) Temperature of steam in exhaust pipe, as observed ... deg. fahr.

Quality of Steam at Throttle

(39) Number of degrees of superheat .... deg. fahr.
(40) Percentage of moisture in steam .... per cent

Total Quantities

(41) Total steam consumed by engine, as measured (see Par. 6)...lb.
(42) Total dry and saturated steam or superheated steam consumed (Par. 11)...lb.
(43) Correction factor conforming to conditions agreed upon (See Pars. 11 and 11a)...
(44) Equivalent total steam consumed, conforming to conditions agreed upon (Item 41 × Item 43)...lb.

Hourly Quantities

(45) Steam consumed per hour as measured (Item 41 ÷ Item 25...lb.
(46) Dry and saturated steam or superheated steam consumed per hour (Item 42 ÷ Item 25)...lb.
(47) Equivalent steam consumed per hour conforming to conditions agreed upon (Item 44 ÷ Item 25)...lb.

Heat Consumption

(48) Total heat above water at 32 deg. fahr. per lb. of steam at throttle...B.t.u.
(*a*) Heat of liquid at temperature of steam at exhaust pressure...B.t.u.
(*b*) Heat supplied per pound of steam...B.t.u.
(49) Heat consumed per hour (See Par. 12)...B.t.u.
(50) Heat available for work per lb. of steam, from adiabatic expansion between initial conditions and final pressure according to Rankine cycle (See Par. 17)...B.t.u.

Indicator Diagrams	1st Cyl.	2d Cyl.	3d Cyl.	
(51) Nominal cut-off...				per cent
(52) Mean effective pressure (avgr.)...				lb. per sq. in.
(53) Maximum pressure above atmosphere...				lb. per sq. in.
(54) Absolute back pressure at lowest point...				lb. per sq. in.

Speed

(55) Revolutions per minute...r.p.m.
(*a*) Variation of speed between no load and full load...per cent
(*b*) Momentary fluctuation of speed on suddenly changing from full load to half load...per cent
(56) Piston speed...ft.p.m.

Power

(57) Indicated horsepower developed by whole engine...i.hp.
(58) 1st cylinder, crank end...i.hp.
head end...i.hp.
(59) 2d cylinder, crank end...i.hp.
head end...i.hp.
(60) 3d cylinder, crank end...i.hp.
head end...i.hp.
(61) Brake horsepower developed by whole engine...b.hp.
(62) Friction of engine Item 57 — Item 61...hp.
(63) Percentage of friction (Item 62 ÷ Item 57) × 100...per cent
(64) Indicated horsepower with no load at normal speed...i.hp.
(65) Mechanical efficiency (Item 61 ÷ Item 57) × 100...per cent

Economy Results

(66) Steam consumed per i.hp-hr. as measured (Item 45 ÷ Item 57)...lb.
(67) Dry saturated or superheated steam consumed per i.hp-hr. (Item 46 ÷ Item 57)...lb.
(68) Equivalent steam consumed per i.hp-hr. conforming to conditions agreed upon (Item 47 ÷ Item 57)...lb.
(69) Steam consumed per b.hp-hr. as measured (Item 45 ÷ Item 61)...lb.
(70) Dry and saturated steam or superheated steam consumed per b.hp-hr. (Item 46 ÷ Item 61)...lb.
(71) Equivalent steam consumed per b.hp-hr. conforming to conditions agreed upon (Item 47 ÷ Item 61)...lb.
(72) Heat consumed per i.hp-hr. (Item 49 ÷ Item 57)...B.t.u.
(73) Heat available according to Rankine cycle per i.hp-hr. (Item 50 × Item 66)...B.t.u.
(74) Heat consumed per b.hp-hr. (Item 49 ÷ Item 61)...B.t.u.
(75) Heat available according to Rankine cycle per b.hp-hr. (Item 50 × Item 70)...B.t.u.

Efficiency Results

(76) Thermal efficiency referred to i.hp. (2547 ÷ Item 72) × 100...per cent
(77) Thermal efficiency referred to b.hp. (2547 ÷ Item 74) × 100...per cent
(78) Engine efficiency (referred to Rankine cycle) based on i.hp. (2547 ÷ Item 73) × 100...per cent
(79) Engine efficiency (referred to Rankine cycle) based on b.hp. (2547 ÷ Item 75) × 100...per cent

Specimen Diagrams

(80) Sample diagram from each cylinder...
(81) Sample steam-pipe diagram...

Note 1: When the engine drives an electric generator the following additional data and results applicable especially to a.c. generators should be entered in the table.

Electrical Data

(82) Average volts each phase...volts
(83) Average amperes each phase...amp.
(84) Power factor...per cent
(85) Total output in kilowatts...kw.
(86) Net output in kilowatts (See Par. 15)...kw.
(*a*) Field volts...
(*b*) Field amperes...

Power and Economy

(87) Electrical horsepower developed (Item 86 ÷ 0.7457)...
(88) Steam consumed per net kw-hr. (Item 45 ÷ Item 86)...lb.
(89) Dry and saturated steam or superheated steam consumed per net kw-hr. (Item 46 ÷ Item 86)...lb.
(90) Equivalent steam consumed per net kw-hr. (Item 47 ÷ Item 86)...lb.
(91) Heat consumed per net kw-hr. (Item 49 ÷ Item 86)...B.t.u.

Note 2: When testing a marine engine having a shaft dynamometer, the form should include the data obtained from this instrument, in which case the brake horsepower becomes the shaft horsepower.

TABLE 2 DATA AND RESULTS OF RECIPROCATING STEAM-ENGINE TEST

(*Short Test*)

(1) Dimensions of cylinders...
(*a*) Diameter of piston and tail rods...
(2) Date...
(3) Duration...hr.
(4) Pressure in steam pipe near throttle by gage...lb. per sq. in.
(5) Pressure in receivers by gage...lb. per sq. in.
(6) Vacuum in condenser...in. mercury
(7) Percentage of moisture in steam near throttle or number of degrees of superheat...per cent or deg. fahr.
(8) Total steam consumed per hour...lb.
(9) Total dry and saturated steam of superheated steam consumed per hour...lb.
(10) Equivalent steam consumed conforming to conditions agreed upon per hour...lb.
(11) Average mean effective pressure in each cylinder...lb. per sq. in.
(12) Revolutions per minute...r.p.m.
(13) Indicated horsepower developed...i.hp.
(14) Steam actually consumed per i.hp-hr...lb.
(15) Dry and saturated steam or superheated steam consumed per i.hp-hr...lb.
(16) Equivalent steam consumed per i.hp-hr. conforming to conditions agreed upon...lb.
(17) Engine efficiency (referred to Rankine cycle based on i.hp.)...per cent

New Process of Steel Manufacture

A company has been incorporated at Etamps, 50 miles south of Paris, for the commercial exploitation of a patented process for manufacturing steel directly from the ore using an inclined rotating furnace similar to that employed in the manufacture of cement.

In this process—the Basset—the ore is charged at the upper end and works its way toward the lower end as the furnace slowly revolves—at the rate of one revolution in three minutes. Pulverized coal is used for fuel. The air which supports the combustion is previously heated about 1000 deg. cent. in a regenerator similar to that connected with an open-hearth furnace. The temperature of the gases as they leave the furnace is said to be 300 deg. cent. and by the nature of the process these gases contain 44 per cent carbon monoxide. This gas of course may be used for heating purposes. The slag is tapped off the top of the metal which is poured into the ingot molds.

It is claimed that three qualities of metal have been produced, including pig iron of a grade between gray and white, hard steel, and malleable iron. These results are obtained by varying the ore charge and the temperature of the process.

It is stated that since the first experiments at the Lavocat Usine at Dennemont, 2000 tons of iron have been produced by this process at Longwy. It also is stated that the Hauts Fourneaux de Caen has produced 500 tons. In the latter district it is now planned to erect a battery of furnaces with a capacity of 2000 tons per 24 hr.

American engineers, says *The Iron Trade Review* of November 11, 1920, will be struck with the similarity between this process and the Jones step process which was the subject of extensive trials at Marquette, Mich., over a decade ago. In view of the utter commercial failure of the Jones process, the progress of the French experiments will be watched with interest.

Forty-First Annual Meeting of the A.S.M.E.

Notable Session on Transportation—Professional Sessions Interested Large Numbers of Membership—Brashear Memorial Meeting—Record Attendance

THE Forty-first Annual Meeting of The American Society of Mechanical Engineers had the distinction of being the richest in professional program of any meeting held by the Society. To this the newly formed Professional Sections contributed greatly. Their coöperation with the Committee on Meetings and Program in the carrying out of their several sessions prophesies a great future for the professional and technical activities of the Society. In fact, the organization of Professional Sections and the consequent quickening of the technical life of the Society is a step that well accompanies the formation of The Federated American Engineering Societies with its avowed purpose of dedicating the organization to service. To be of service the technical society must be intensively organized technically, and the Professional Sections fill this requirement in The American Society of Mechanical Engineers.

In the arrangement of general Professional Sessions this year no more than three papers were assigned to any session. This arrangement coupled with the adoption of limiting times for the presentation and discussion of these papers, insured more completely the carrying on of the meeting according to schedule and still permitted adequate time for the discussion of each paper. This arrangement, however, is subject to change and members are requested to send in to the Secretary any comments or criticisms of the new rules or the new arrangement of sessions.

The meeting formally opened on Tuesday, December 7, and contrary to the usual procedure, three sessions were held Tuesday afternoon. On Monday, however, the Local Sections' delegates gathered for their annual conference, which proved of great value as a meeting place for the discussion of Local Sections' problems and for the advancement of new ideas in Society policy. A more complete account of the Local Sections' Conference will be given in Part Two of the February issue.

The social functions consisted of the Presidential Reception on Tuesday evening, and the Ladies' Reception, Tea and Dance on Thursday afternoon. Thursday evening being left open for other than Society activities, a number of technical schools availed themselves of the opportunity for Reunion Meetings. The most notable of these was the meeting of the New York Alumni of Worcester Polytechnic Institute in honor of Governor-Elect Lake of Connecticut.

Wednesday evening was devoted to a memorial meeting in honor of the late Dr. John A. Brashear, Past-President of the Society. Mr. Worcester R. Warner, after a few words bearing on his intimate connection with Doctor Brashear, introduced the orator of the evening, Dr. Henry S. Pritchett, President of the Carnegie Foundation for the Advancement of Teaching. An abstract of Dr. Pritchett's address, entitled John Alfred Brashear, Humanitarian and Man of Science, is printed on page 39 of this issue.

Edwin S. Carman — President, 1921
The American Society of Mechanical Engineers

Only one formal excursion was organized, the studio of the Metro Picture Corporation being visited. Small groups of members, however, were conducted to points of interest throughout New York City.

Registration totaled 2171, of whom 1368 were members and 803 guests—from twenty-nine states, Canada and France. This number exceeded last year's attendance, which was the largest previously recorded.

Presidential Address and Reception

The meeting was formally opened on Tuesday evening with President Miller's address on The Engineer's Service to Society, which appears as the first article in this issue. Following the presidential address, honorary memberships were conferred upon the following men:

Captain Robert Woolston Hunt, of Chicago, Ill., Past-President of the Society and John Fritz Medallist, for his life-long and eminent achievements in the field of engineering, and particularly in connection with the steel industry;

Rear-Admiral Robert Stanislaus Griffin, of Washington, D. C., for his signal contributions to the engineering work of the naval forces of the United States during the World War;

Dr. Samuel Matthews Vauclain, of Philadelphia, Pa., Past-Vice-President of the Society, for his many important contributions to the mechanical engineering of the steam locomotive;

Honorable Sir Charles Algernon Parsons, of London, England, for his valuable contributions to the development and construction of the steam turbine which has now become an essential prime mover;

Lord William Weir, of Glasgow, Scotland, for his energy and genius in the organization of war work in the British Isles, and particularly as Director-General of Aircraft Production in the Ministry of Munitions; and

Grande Ufficiale Ingegnere Pio Perrone, of Genoa, Italy, for the unselfish devotion of his engineering and manufacturing skill to the cause of his country in the World War.

The first three recipients were present; official documents of honorary membership will be conveyed to the others through the American ambassadors in their respective countries.

The report of the tellers of election was presented by Dr. H. G. Tyler, who announced the election of officers for the ensuing year as follows: *President*, Edwin S. Carman, Cleveland, Ohio; *Vice-Presidents*, Leon P. Alford, Montclair, N. J., J. L. Harrington, Kansas City, Mo., and Robert B. Wolf, New York, N. Y.; *Managers*, Henry M. Norris, Cincinnati, Ohio, Louis C. Nordmeyer, St. Louis, Mo., and C. C. Thomas, Los Angeles, Cal.

President-Elect Edwin S. Carman was escorted to the platform by James Hartness, Governor-Elect of Vermont and Past-President of the Society, and Ira N. Hollis, Past-President of the Society. President Miller was welcomed to the past-presidency and back to

the membership of the Society by Governor Hartness and the new president was welcomed by Major Miller, who spoke of the services rendered by Mr. Carman as president of the Cleveland Engineering Society and as Chairman of the Local Sections Committee.

In acknowledging his election, Mr. Carman spoke briefly of the manner in which engineers should deal with professional matters, pointing out and emphasizing the fact that engineers, more than any other body of men, cannot attain satisfactory results without getting at the truth of every problem. The same accuracy which he must observe in designing a machine, Mr. Carman said, should be applied to every problem which the engineer undertakes.

Following these ceremonies the Presidential Reception was held and the remainder of the evening was devoted to dancing.

Business Meeting

President Fred J. Miller opened the Business Meeting on Wednesday morning with a few remarks on the growth of the Society, its participation in matters affecting the public welfare, especially its support of The Federated American Engineering Societies, and restrictions necessitated by increased costs. Reports of the various Standing and Special Committees of the Society were then presented by title by Secretary Rice. An abstract of these reports will be found in Section Two of this issue of MECHANICAL ENGINEERING. The importance of the work of these committees was brought out by Secretary Rice.

The first report to be discussed was that of the Code of Ethics Committee. Prof. A. G. Christie, chairman of this committee, read the report and moved its adoption. The discussion which followed centered around the phraseology of the code, its purpose, and whether it should be the product of one man, a committee, or such an organization as The Federated American Engineering Societies. It was felt by many that the wording and style of the code should be changed so that it would be free from any possible criticism as to its English. A code so important, it was pointed out, should be couched in the purest possible language. There seemed to be considerable discussion, also, as to whether or not the purpose of the code was clearly understood. Several expressed the opinion that the code was not necessary as a guide for engineers, but should be a declaration of principles or a guide to the public as to what might be expected from the engineers in this and other societies. It was further suggested that the code should be an Engineers' Code, applicable to all engineers, rather than to mechanical engineers alone. It would thus become a creed for all engineers, a statement of their ideals, a standard for them in their work and at the same time a pledge to the public.

It was thought by some that a better code could be formed by one person, and the names of Felix Adler, an expert on the subject of ethics, Herbert Hoover and General Wood, for their knowledge of engineering, and President Wilson, for his mastery of the English language, were suggested as men to whom the code might be submitted for revision. Others felt that if the code were to apply to all engineers it might best be framed by the newly organized Federated American Engineering Societies, but it was argued that it might be some time before this body would be ready to consider codes and that in the meantime, both as a matter of courtesy to the committee which had drafted the code and as a means of keeping the work alive, the code should be referred back to the committee.

The motion which was finally carried was that the report be referred back to the committee for such action as they might deem wise, either for the modification of the code itself, for conference with other societies, or for the purpose of submitting the recommendations of the committee to The Federated American Engineering Societies. Professor Christie closed the discussion with the hope that further criticisms of the code would be sent to the committee.

Secretary Rice stated that the reports read by title should be discussed by correspondence. Among these he named the reports of the special committee on Standard Tonnage Basis for Refrigeration, Fluid Meters, and Bearing Metals; the special committee on Industrial Engineering; committee on Power Test Codes (General Instructions); special committee on Weights and Measures; special committee on Feedwater Heater Standardization; committee on Education and Training; and the committee on Awards and Prizes.

Professor H. S. Philbrick, secretary of the Sections Conference, read the report of that Conference, at which it was voted that junior members shall not be given the voting privilege in Society affairs, and the following names for the 1921 Nominating Committee were presented: Elmer Smith, Boston, Mass.; G. K. Parsons, New York; W. W. Varney, Baltimore, Md.; B. S. Hughes, Buffalo, N. Y.; W. M. White, Milwaukee, Wis.; F. E. Bausch, St. Louis, Mo.; and E. O. Eastwood, Seattle, Wash. The report was adopted.

F. E. Matthews, president of the American Society of Refrigerating Engineers, read the report on the Standard Tonnage Basis for Refrigeration. This report has been adopted by the joint committee of the Mechanical Engineers and Refrigerating Engineers, and by the American Society of Refrigerating Engineers itself. The report was referred back to the committee, to be presented at the next Council Meeting and brought up again at the Spring Meeting of the Society.

The meeting closed with the award of the Student Prize, details of which will be found elsewhere in this issue.

The meeting was adjourned until Friday afternoon for the presentation of two amendments to the Constitution, the report of the delegates to the American Engineering Council, and a statement on Appraisal and Valuation by Mr. James R. Bibbins, but unfortunately, when Friday afternoon came, no quorum could be obtained and no meeting was held.

DISCUSSION AT FUEL SESSION

(Continued from page 31)

not ideal conditions showed that over 60 per cent of the miscellaneous plants and 50 per cent of the chemical plants had an efficiency of less than 60 per cent. Analyses of the flue gases in these same plants showed that over 40 per cent of the chemical plants and over 65 per cent of the miscellaneous industrial plants had a very poor combustion efficiency, with less than 8 per cent of carbon dioxide present in the gas.

An estimate of efficiency and heat losses in the average boiler plant in the United States, reproduced in Technical Paper No. 205 of the Bureau of Mines, showed only a 57 per cent efficiency. A study of the situation shows that the efficiency should be increased to at least 67 per cent. Many authorities agree that the average efficiency may safely be considered as not over 60 per cent, leaving a large margin for possible saving in the average plant.

WILLIS LAWRENCE. The operator of the modern power house, even if he is familiar with the technical features of conservation, has little time to devote to experiments and tests to develop and maintain an efficient system of firing, so that the burning of fuel is not, as a rule, conducted on the highest plane of efficiency. Under such conditions the logical relief lies in supervision by a permanent outside organization which is in touch with the entire field of engineering, and has abundant research and test data, together with the practical experience which the individual plants can contribute. Such a source of help, whether federal, state or community, would be welcomed by the operators of fuel-burning plants, as it would relieve them from the burden and responsibility which they now carry. At the same time it would assist in a wonderful conservation of fuel.

CHARLES R. SCHMIDT. The first point in Mr. Myers' paper on fuel conservation, namely, the regulation of the quality of fuel, is perhaps the most important because it is "the foundation in the economical use of bituminous coal." The writer advocates the crushing and washing of all bituminous coal at the mines and suggests that the Federal Government furnish the crushers and washers to the operators, charging them 6 per cent on the investments plus the upkeep charges of the equipment, which would remain the property of the Government and in charge of the engineers from the Bureau of Mines. Also, as soon as enough mines are equipped with crushers and washers it should be made unlawful for anyone to sell or transport any but crushed and washed bituminous coal. We have a pure-food law; why cannot we have a pure-fuel law?

John Alfred Brashear—Humanitarian and Man of Science

Oration in Memory of the Late Dr. John A. Brashear, Past-President of The American Society of Mechanical Engineers, by Dr. Henry S. Pritchett, President of the Carnegie Foundation for the Advancement of Teaching[1]

Adhuc scholasticus tantum est; quo genere hominum, nihil aut est simplicius aut sincerius aut melius.

I AM asked to speak before this body of trained engineers touching the scientific work of John Alfred Brashear. For nearly forty years I had the pleasure of his friendship and companionship. It is not easy under such circumstances to differentiate between those qualities in a man's life that pertain to his science or to his profession and those deeper and simpler relations that belong to friendship.

My purpose in speaking before this body of scientific men is not so much to tell the story of his life as to call attention to his contributions to optical science and research and his relation to some of those great forces in our social order which went to the making of a character like Brashear.

He was born almost exactly eighty years ago in what was then the little village of Brownsville, about thirty miles south of Pittsburgh. His father was a mechanic and the boy grew up under surroundings that intensified his natural aptitude for machinery. His mother's father was a watchmaker. From him the boy acquired not only his taste for technique of fine tools but he also imbibed from him early in life that love of astronomy which was perhaps his ruling passion.

Brashear's formal education was obtained in the public school of Brownsville which he attended until he was about thirteen years old, when it became necessary for him to earn his own living. Accordingly he went to Pittsburgh, learned the patternmaker's trade, and sought employment in one of the steel mills where he remained for twenty years, developing into an expert mechanic and becoming, toward the end of this period, the superintendent of a rolling mill.

During this period of his life as a practical mill mechanic he was under two strong influences, the one appealing to the spiritual side of his nature, the other to his intellectual side. He was a devout member of the Methodist Church and having a facility in public speaking he came to take an increasing part in the religious exercises of his denomination, until finally he came to believe that his path of duty lay in the ministry.

Side by side with this absorbing and insistent motive there grew up in his life another equally insistent and equally influential source of action. Early in his mill days Brashear had acquired a small refracting telescope. With this modest instrument he observed the moon and the principal planets, some of the star clusters and nebulæ. These views merely whetted his thirst and he began to long for something better than this small and inferior objective. Having no money there was but one way to get it and that was to make it himself; and so in the little shop at the back of his house, he and his wife began the grinding of a five-inch refractor. The story of this refractor has often been told.

These two motives, a deep and fervent humanitarianism and a passionate devotion to science were to be the dominant influences of his life. He never gave himself wholly to either the one or the other. Always he was the humanitarian, and always he was the man of science. Doubtless the impulse toward both of these lines of action arose from the same thing—the possession of a keen and ardent imagination. We do not always realize that the vision of human destiny and human progress that brings men with complete devotion into the service of their fellow-men is closely akin to that other vision of the forces and operations of nature, whether exercised upon the molecule or upon the stars, which also brings men irresistibly into the service of knowledge. Imagination, keen, far-sighted, sympathetic, may equally well lead its possessor into the one path as into the other. With Brashear it was a question hard to decide whether he should travel his life journey by the one way or by the other.

It seemed at one time of his life that he had definitely turned toward the ministry. His intention to be a Methodist minister was publicly announced. On one or two occasions he undertook to conduct formal service, but in the end he convinced himself that he was a better mechanic than he was a preacher, that he could serve God better as a layman than as a minister. In the meantime the lure of the telescope was drawing him more surely into the service of science. It needed only the association with Langley to make him a lifelong worshipper at the altar of science, equally inspired by the beauty of the planets and the perfection of a prism.

Encouraged by Langley's praise of the five-inch lens, Brashear immediately began in 1875 a twelve-inch reflecting telescope which he completed in 1877 and which he used for some three years afterward in a study of the lunar crater Plato. During these years also Brashear became more and more the mechanical and optical assistant of Langley in his reseaches on radiant heat.

It was a fortunate chance that brought Langley, the astronomer, and Brashear, the mechanician, to the solution of a common problem, a process that also knit two great souls in a lasting and devoted friendship. To the men of our day, living amid the engrossing and insistent demands of civilization as it has developed in the last fifty years, it is not easy to picture the scientific enthusiasms that made possible in that day an astronomical observatory in the City of Pittsburgh, and which furnished at the same time the inspiration of a technician like Brashear and of an astronomer like Langley. The rise of the Allegheny Observatory is a part of the romance of the astronomy of the middle half of the nineteenth century.

Between 1840 and 1860 there was a popular passion for astronomy that was widespread, which took hold upon the imagination of the people of the United States as perhaps no other science has ever done. This enthusiasm had its origin in two things. The improvement of the telescope and of the optical means for the manufacture of telescopic lenses and mirrors had resulted in the interesting discoveries of Herschel, in the invention of the spectroscope and had aroused the general expectation that the telescope would soon reveal new wonders of the heavens to the eyes of men. Furthermore, in that day most of the information in regard to science was disseminated through the medium of public lectures. The all-pervading newspaper had not come to dull the thirst for knowledge and to satiate the curiosity for news.

This popular interest in the science of astronomy was greatly quickened by the appearance of Donati's comet in 1858. This was one of the most glorious heavenly visitors that have ever come within human ken. At its brightest the comet reached from the zenith to the horizon and the nations of the world gazed at it with awe and admiration.

The establishment of the Allegheny Observatory was a part of the romance of this movement. In February, 1859, in the glow of the enthusiasm created by Donati's comet, a few citizens came together to consider the purchase of a telescope which in their own language "should have the magnifying power which would bring the heavenly bodies near enough to be viewed with greater interest and satisfaction." The association was called in its earlier days the Allegheny Telescope Association, but it did not attain its object until after the expiration of ten years when it found itself in the possession of a telescope of thirteen inches aperture, at that time an instrument of extraordinary power.

I have dwelt with some length on the astronomical enthusiasm of the period between 1840 and 1860 and of the founding of the Allegheny Observatory because in this movement and in the founding of this observatory lay the forces which transformed John Brashear from a skilled mechanic into a maker of great lenses and the perfecter of the most delicate instruments of spectrum analysis.

When Brashear brought to Langley in 1875 his little five-inch

[1] Delivered December 8, 1920, at the Annual Meeting of The American Society of Mechanical Engineers, New York.

lens, Langley was engaged in a research into the problem of the selective absorption of radiant heat. Astronomy at that day was just beginning to turn from the old astronomy, which concerned itself with a right ascension and declination of stars, their proper motion, and their distances, to the study of the physical nature of the sun and of the stars made possible by the invention of the spectroscope and the gradual advance of photographic art. To carry on such researches as Langley was engaged in, there was needed not only a telescopic lens but also the most refined and delicate mechanical instruments. When Langley gave his kindly welcome to the mechanician Brashear with his imperfect lens, he had little reason to suspect that he was to find in him a coadjutor whose coöperation was to make his work glorious in the annals of astrophysics. Brashear became his indispensable aid.

Between 1875 and 1880 he had made a number of pieces of apparatus for Professor Langley to be used in connection with his study of radiant heat. By that time he had become so interested in these problems that he gave up his work in the steel mill and began making telescopic lenses and mirrors as well as other optical apparatus in his own shop established in 1880.

His first great success was attained in the silvering of the mirrors for Professor Langley's Mount Whitney expedition in 1881. His next achievement in Langley's researches was the invention of a method for polishing rock-salt prisms. Rock salt crystallizes in cubes. It has the remarkable property of transmitting heat rays and was therefore specially adapted for Langley's researches in radiant heat. On account, however, of its softness and its dull color it is difficult to obtain prisms or lenses that will take a high polish. Brashear overcame all these difficulties and produced rock-salt prisms and lenses which were not only used in Langley's researches but were immediately adopted by European astrophysicists.

About this time also he became much interested in the work of Professor Rowland of Johns Hopkins. The spectrum studied in the spectroscope is produced by a dispersion of rays of light in passing through a series of prisms due to the varying refraction of light of different wave lengths. Soon after the discovery of the spectroscope and the adoption of the undulatory theory of light, it was found that a spectrum resembling the prismatic spectrum could be produced by the diffraction of light waves from a ruled surface, the difference in the light phase being proportional to the number of rulings. Professor Rowland in the effort to perfect a machine capable of making a great number of lines on a hard surface so as to obtain gratings suitable for determination of the lengths of the light waves invoked Brashear's assistance. After a year of hard work he succeeded in overcoming the mechanical difficulties and Professor Rowland was able to rule gratings containing many thousands of lines to the inch.

In 1885 Brashear completed his first large spectroscope and in 1887 he completed what was then the greatest spectroscope of the world for the Lick Observatory, with which Professor Keeler made his famous investigations on the motion of the nebulæ in the line of sight. Other great spectroscopes followed in the years immediately succeeding. About this time also Brashear became interested in the work of Professor Michelson on the determination of the velocity of light and also on the measurement of velocities as existing between long and short waves. His aid was enlisted in the first refractometer which was used to measure the meter of the International Bureau in terms of light waves. He succeeded in reducing the limiting error of the optical surface to less than 5/100 of the wave length, a marvelous achievement in optical construction.

In the early nineties Brashear constructed for Prof. George Hale the first spectroheliograph for the automatic photography of the surface and surroundings of the sun. This work has been epoch-making in the realm of solar photography.

Meantime in his optical works Brashear was constructing objectives and mirrors for reflecting telescopes and for refractors of larger and larger aperture. Among the largest of these are the 16-in. refractor of the Carleton Observatory, the 18-in. refractor for the Lowell Observatory, and finally the 30-in. Cassegrain for the Allegheny Observatory, completed some ten or twelve years ago, and the 72-in. reflector for the Dominion Observatory at Victoria. He succeeded the Clarks as the great lens maker of America, but unlike them his marvelous mechanical knowledge and skill extended to almost every field of solar investigation. As the Clarks were the representatives of the old astronomy in the manufacture of great refractors, so Brashear became the representative of the new astronomy in the realm of mechanical and technical advancement. There have been in America three manufacturing firms who have had a notable part in the advancement of astronomy and stellar physics—Alvan Clark and Sons of Cambridgeport, the makers of the great refractors; Brashear and McDowell of Pittsburgh, also makers of lenses and of mirrors, but preëminent in the making of delicate prisms and tools needed in the new astronomy; and, finally, Warner and Swasey of Cleveland, the engineers of both the old and the new astronomy, whose designs and constructions have made possible the telescope tubes and the great installations necessary to operate the modern telescope with its spectroscope and photographic attachments.

Among Brashear's many achievements in aid of astronomy was the manufacture of photographic doublets designed to photograph in a single exposure a wide field. Among the most ingenious of these instruments were the great cameras made for Dr. Max Wolf of Heidelberg which were used for the photographic discovery of asteroids.

In the days between 1840 and 1860 when Brashear received those deep impressions which centered his interest upon astronomy, asteroid hunting was a favorite sport of the astronomer, and the discovery of an asteroid brought fame to the finder. In that day the discovery and the pursuit of these little planetoids was purely the work of the mathematical astronomer working with the ordinary refractor. It would have been a bold prophet who could have foretold fifty years ago that a highly trained mechanician and technologist like Brashear would have anything to do in the discovery of these little planets between Mars and Jupiter, but the wonderful photographic cameras which he made for Dr. Wolf were so effective that they quickly superseded all other means of asteroid hunting.

Brashear as a scientist, therefore, stands as the great technician of the new astronomy. His lenses, his mirrors, and his prisms, his gratings and his stellar cameras made possible those refined observations which have opened a new chapter in our knowledge of the physical conditions of the stellar universe. Astrophysics is not different from other physics except that it studies the physical properties of highly heated bodies millions of miles away. The lens of the telescope is only an incidental part of the apparatus used and the great results are gained by the perfection of those delicate instruments which are able to recognize a small displacement of an absorption line in the spectrum of the sun, of the stars and of the nebulæ. Brashear's scientific fame rests on these great achievements. He stands in the history of science as the master mechanic of the new astronomy.

The last fifteen years of Brashear's life saw him turn once more to the passion of his earlier years. With him the humanitarian and the scientific imagination had lived side by side and in his last years, and particularly after the death of his faithful wife, the old passion for human brotherhood once more became the dominant factor in his life. His work as Chancellor of the University of Pittsburgh, as administrator of Mr. Frick's gift for the teachers of Pittsburgh, and his untiring service to the Carnegie Institute and the educational interests of Pittsburgh was the expression of the devotion which had always been a part of his life and which became in his last years the moving force of his existence. Into all this work he threw a devotion and a sweetness of personality which made him a power in increasing and deepening those forces in education that made for good will and right living and earnest devotion. He did not pretend to be an expert in the organization or direction of formal education, but he was a missionary of kindliness and human service to those who wrought in formal education. After one of his astronomical lectures to the West Point cadets a very discriminating listener, himself an astronomer, said to Brashear, "Those boys will soon forget what you have said to them about astronomy but they will never forget you." It was a true word. Brashear's service to education was the gift of his own personality alive with the twin passions for science and for humanity.

SURVEY OF ENGINEERING PROGRESS

A Review of Attainment in Mechanical Engineering and Related Fields

Recent Papers Relating to Marine Engineering

PROGRESS IN OIL-BURNING PRACTICE IN THE NAVY AND MERCHANT MARINE

Recent Advance in Oil Burning, Ernest H. Peabody, Mem. Am.Soc.M.E. In the field of oil burning, as in many others, it is the U. S. Navy that is pointing the way to future developments. While oil burning has been and is extensively used in the merchant marine, it is carried out by means of comparatively small units both at the boiler end and at the oil-burner end. In fact, the author states that there is probably no single oil burner in the merchant marine capable of atomizing over 600 lb. of oil per hour, while the oil burned per hour per square foot of heating surface under forced-draft conditions is under one-half pound. This means that the full value of the use of oil fuel has not yet been approached and while savings and advantages in the use of oil fuel have been realized, all the possibilities of it have not yet been reached. For this there are good reasons, one of the most important being the fact that oil fuel has been applied to Scotch boilers and the above figures marked practically the limit to which such boilers may be forced with safety. Furthermore, certain limitations in the design used in the merchant marine are imposed by the existing types of condensers and evaporators.

In marked contrast to this the Navy Department is making rapid advances of an important character. In fighting ships it is now using water-tube boilers entirely, with improved condensers and evaporators, and the oil burners have been brought to a point where in recent tests it proved possible to atomize more than one ton of oil per hour per burner.

This apparently sounds the doom of the Scotch boiler. In the near future instead we shall have large economical water-tube boilers installed in closed firerooms, burning oil and operating under forced draft with a few large-unit mechanical atomizers.

A series of interesting tests were recently carried out at the Navy Fuel Oil Testing Plant using a small-tube express-type water-tube boiler of the White-Forster design, built by the Babcock and Wilcox Company and containing 7565 sq. ft. of heating surface and 753 sq. ft. of superheating surface, the furnace volume being 751 cu. ft. Three different types of air registers were used, two of the Bureau of Engineering with forced-draft and natural-draft design, and one Peabody register of the Babcock and Wilcox Company on which either forced or natural draft could be used.

The data of these tests are given in Fig. 1. In the tests of June 10 there were 11 boilers in operation, each atomizing 1032 lb. of Navy standard oil (25.5 deg. B.) per hr., giving a consumption of 1.5 lb. of oil per sq. ft. of heating surface per hr. The evaporation of water per pound of oil from and at 212 deg. fahr. was 15.14 lb., giving an evaporation of water per sq. ft. of heating surface per hr. of 22.73 lb. from and at 212 deg. with an efficiency of 76.15 per cent. The air pressure in the closed fireroom was 9.5 in. and the rate of combustion per cubic foot of furnace volume reached the very high figure of 15.12 lb. of oil per hr. It is believed that this test stands as a world's record for efficiency at high boiler and furnace capacity.

The record of 1032 lb. of oil per burner per hr., however, has been already outstripped in tests made on an enlarged type of the Babcock and Wilcox air register with mechanical atomizers which proved actually capable of atomizing over 1500 lb. of oil per hr. under conditions similar to those in the U. S. scout cruisers now under construction; and even this record was exceeded when, in a test of a Normand boiler at the Fuel Oil Testing Plant, Peabody-Fisher wide-range mechanical burners atomized over 1800 lb. of oil (crude Mexican of 13.3 deg. B.) per burner per hr., without smoke, carbon or other objectionable conditions. In these tests the oil burned per sq. ft. of heating surface was 1.2 lb. per hr., and per cu. ft. of furnace volume, 11.15 lb. per hr. It is claimed, however, that a record of atomization at the rate of 2287 lb. per burner per hr. has been attained for a short time.

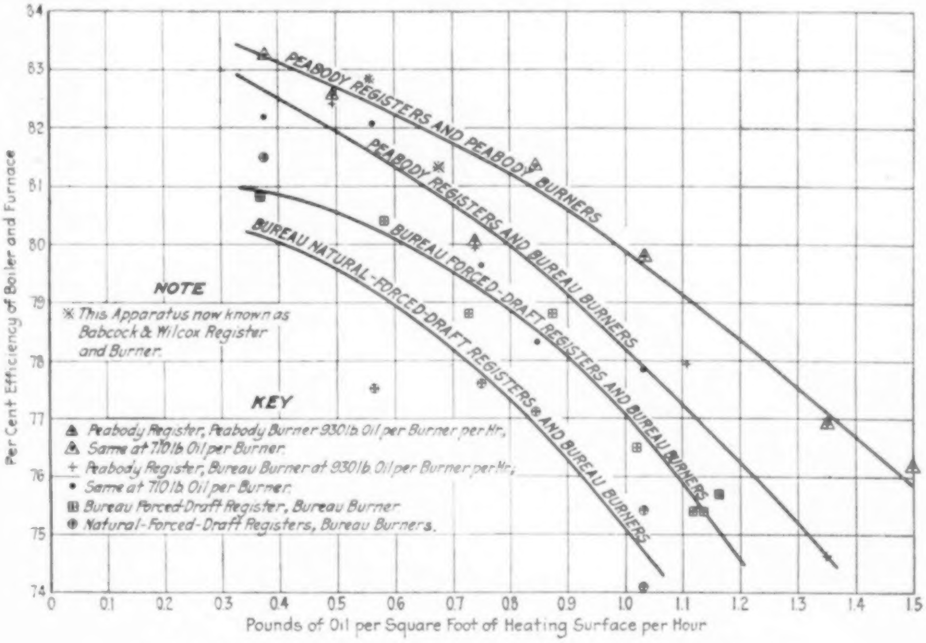

Fig. 1 Data of the White-Forster Boiler Tests Carried out at League Island Navy Yard Fuel-Oil Testing Plant

In this connection attention is also called to Fig. 3 giving data of one of the tests on a White-Forster boiler in which efficiency for boiler and furnace, in per cent, is plotted against boiler output.

These tests are too recent to make it possible to foretell their precise significance, but they point to important possibilities such as the use of a few very large boilers to obtain great outputs of power. Mr. Peabody expresses the conviction that the large unit both in boilers and oil burners has come to stay and that the trend of modern development is certainly in the direction of larger units and the higher capacities made possible by the use of fuel oil.

An important development in the design of oil burners has been that of making their operation more flexible. The mechanical atomizer of the usual design has a decided limitation in range, as it cannot be operated at low capacity if it is designed for a high one. The lower limit with the oil pressures ordinarily used is approximately one-half the upper. The reason for this is that the burner depends for its atomizing effect on the centrifugal force induced by giving the oil a rapid whirling motion in the central chamber of the tip. This whirling motion, in turn, is produced by delivering the oil to the central chamber through eccentric passages or

small channels substantially tangential to the walls of the chamber. As the capacity of the burner is reduced by reducing the oil pressure, the velocity through the channels decreases and friction losses grow until finally the spraying effect is reduced to the point where the oil issues from the tip in a solid stream or in a spray too coarse and excessive to give the desired results.

In the Thornycroft atomizer the size of the tangential channels may be reduced by an adjustment in the burner. This gives a greater flexibility to the burner, but it has been found difficult in practice to make individual adjustments under service conditions. The only other procedure, namely, to shut off some of the burners at low powers, or to change the size of the tips, or to do both, can be followed, but is open to objections.

Another and radically new plan, however, has been devised, which promises very satisfactory results. This consists in maintaining the whirling motion in the central chamber of the tip undiminished, whatever may be the capacity desired of the burner

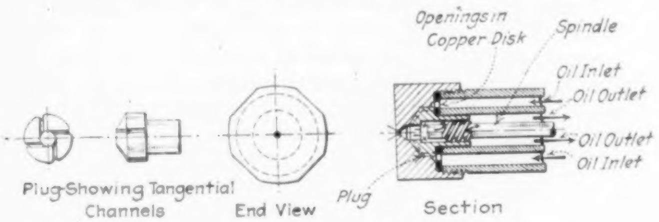

Fig. 2 Fisher Burner Used in U. S. Navy

in other words, instead of delivering through the orifice all the oil which enters the burner chamber, as is invariably done in all other mechanical atomizers, a part of the oil supply is diverted or bypassed from the central chamber and returned to the pump suction, and the actual effective capacity or amount of oil which is sprayed into the furnace depends merely on the proportion of the oil that is bypassed to the total amount entering the burner. Thus, as the amount of oil entering the central chamber through the tangential

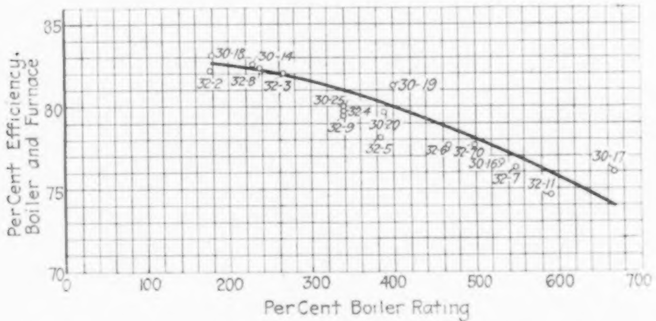

Fig. 3 Efficiency vs. Boiler Output, White-Forster Boiler

slots remains at all times at the maximum, the whirling of the oil and the atomizing effect remain also at a maximum, so that a perfect spray is secured whatever the capacity, at low powers as well as at the highest rate. By this method the range of the atomizer is very greatly increased, and, instead of being limited at the low powers to 50 per cent of the maximum, a good spray can be secured all the way down to about 10 per cent of the total.

This method of spraying is the invention of Commander J. O. Fisher, U. S. N., now fleet engineer of the U. S. Atlantic fleet. He first applied it in an attempt to spray oil into the cylinders of an internal-combustion engine, where, owing to the intermittent action required, the ordinary mechanical atomizer was an entire failure. By introducing the bypass a continuous flow was secured, even when the regular outlet orifice was closed. The application of the principle to atomizers for boiler work followed, with the result that a single burner without change of tip could be used over a greatly extended capacity range. The Navy Department has applied the Fisher burner with great success to small boilers of the launch type, where its wide range enables them to operate the boiler with only one burner. The author shows the navy design of this burner in Fig. 2. The company with which he is at present connected has developed a modified form of the Fisher burner with which some interesting experiments have been carried out with the coöperation of the Navy Department. It is believed that the wide range in capacity will make the burner especially useful for fluctuating loads or in any installation where it is now necessary to change the tips or close off a portion of the burners.

It may be of interest to state that the burners having a maximum hourly output of 1820 lb. which were tested at the Fuel Oil Testing Plant were successfully operated at 250 lb., while smaller tips designed for a maximum of 800 lb. were operated at a minimum of 80 lb. per hr. In the design described by the author the spindle shown in Fig. 2 has been dispensed with and the capacity is controlled entirely by an external valve in the bypass return line, so that by the manipulation of this valve any number of burners can be simultaneously increased or decreased in capacity over the entire range. Also, the tangential channels and the outler orifice are in a single piece. (Abstract of paper read at the 28th general meeting of the Society of Naval Architect and Marine Engineers, New York, Nov. 11–12, 1920.)

TESTS ON METHODS OF INJECTING FUEL OIL IN DIESEL ENGINES

Some Experiments in Connection with the Injection and Combustion of Fuel Oil in Diesel Engines, Prof. C. J. Hawkes. Data of experiments carried out with solid-injection and air-injection systems.

The solid-injection tests were carried out on a single-cylinder four-stroke engine in the Admiralty Engineering Laboratory. The engine is fitted with the piston of an aluminum alloy, has a cylinder diameter of $14^1/_2$ in., a stroke of 15 in. and develops 100 b.hp. at 380 r.p.m. The solid-injection fuel valve used during most of the experiments was of the direct-lift type, that is, the fuel-valve spindle which passed through a gland was operated directly by the fuel-valve lever.

The fuel used was shale fuel oil having a viscosity of 43 sec. at 70 deg. fahr. (Redwood No. 1). Because of the use of very small holes in the sprayer the oil was carefully strained through strainers fitted both on the suction side and on the discharge side of the fuel pump, the latter between the pressure gage and the fuel valve.

One of the objects of the experiments was to ascertain the effect of varying the bore and size of the holes in the solid-injection sprayer.

The first sprayer used was provided with five holes 0.019 in. in diameter and was similar in design to the sprayers fitted in submarine engines in 1914.

Next, the sprayer shown in Fig. 1 was tested. Here the fuel sprays were passed over the heated surface and each of the five holes was surrounded by a steel trumpet expanding from 1/16 in. to 3/16 in. in three-quarters of an inch. As the fuel valve in the experimental engine was inclined to the axis of the cylinder, a large portion of some of the trumpets had to be cut to allow the fuel valve to enter the cover. This modified sprayer did not prove successful and gave only 65 b.hp. When the valve was removed and examined, it was found that the interior of each trumpet was quite clean and bright, but there was a considerable carbon deposit on the external surface. Apparently the jets of oil had been striking the inner surface of the trumpets and it was decided to ascertain the effect of increasing the size of each trumpet so that it expanded from 1/8 in. to 5/16 in. in three-quarters of an inch. This alteration resulted in increasing the power to 95 b.hp. at 380 r.p.m., but after 40 min. running the power dropped to 90 b.hp. An examination of the trumpets showed that the jets had again been striking the sides and dribbling had occurred. The color of the trumpets also indicated that they had been comparatively cool and had not reached the red heat. The design was therefore abandoned.

Several tests were then made with sprayers provided with holes smaller than the standard 0.019 in. With 0.016-in. holes good results were obtained with an appreciable decrease in fuel as compared with the larger holes. Tests were then made with fitting steel plates to the top of the aluminum-alloy piston.

It did not appear, however, that the plates assisted combustion

in any material way. An increase in the temperature of the fuel oil on the delivery side of the pump did not bring any improvement either. The unsatisfactory results with the use of plates on top of the aluminum-alloy piston were apparently due to delayed combustion and possibly to some of the particles of fuel oil assuming the spheroidal state on striking the hot piston, thus delaying vaporization and combustion. On the other hand, however, in tests where heavy petroleum oil was allowed to flow in drops through a distance of about 6 in. on a heated steel plate, it did not show a clear spheroidal state. In tests, however, with shale fuel oil at about 250 deg. fahr. the drop of oil on reaching the plate broke into a number of smaller drops and assumed the spheroidal state. The occurrence of this state was observable until the plate reached a temperature of 600 deg. fahr. which was the highest temperature required in the tests.

If any portion of the injected oil assumed a spheroidal state on reaching the piston there would be a slight delay in combustion and the question of what proportion of the fuel oil which reached the piston remained in contact with it is discussed in detail by the author, who comes to the conclusion that both increased fuel consumption and delayed combustion with the hot plates may have been due either to the oil globules which assumed a spheroidal state on reaching the piston or to very rapid vaporization. This latter would appear to be an ideal condition so long as it is accompanied by good distribution.

Tests of variable fuel-injection pressures have shown that up to a certain point increase of pressure slightly reduced fuel consumption, but increase in fuel-valve roller clearance beyond a certain point did not give any better results and it was also noticed that the fuel-valve roller did not follow the contour of the cam.

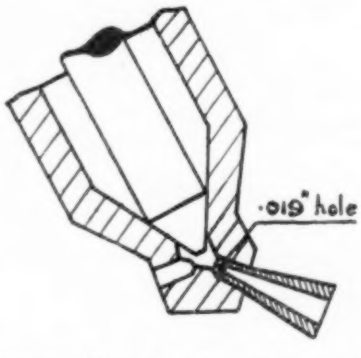

FIG. 1 EXPERIMENTAL NOZZLE FOR SOLID-INJECTION MARINE DIESEL ENGINE

Because of the lack of space the various valve-lift diagrams reproduced and discussed in the original article cannot be used here. Attention is directed, however, to Fig. 3, which presents the data of tests on fuel valve, cam, spring, etc., showing, among other things, under what conditions jumping of the fuel valve was likely to occur. Curve *a* represents the curve of velocity of opening and closing of the fuel valve; curve *b* the forces necessary to accelerate and decelerate the valve, etc.; curve *c* the load due to a 618-lb. spring; and curve *d* the spring load available after deducting the force necessary to accelerate or decelerate the valve and its operating gear.

Curve *e* represents the unbalanced oil pressure on the valve on the assumptions that the full pressure is acting during the opening and closing periods of the valve, and that the pressure drops uniformly in the system from 4500 to 3500 lb. per sq. in. The former is not of course correct for all positions of the fuel valve, but the latter is approximately correct. Curve *f* shows a similar curve, but its assumes that the pressure in the system drops uniformly from 3000 to 2000 lb. per sq. in.—which was the pressure for which the system was originally designed.

The critical period is undoubtedly when the valve begins to close, and if the full pressure acts on the underside of the valve during this period—and it probably does during the early portion of the closing period—it will be seen that the balance of spring load available to overcome gland friction is practically negligible with the higher fuel pressures assumed. Gland friction is acting against the spring during the closing period, while the unbalanced pressure on the valve is always acting against the spring.

Fuel-valve gland friction is difficult to estimate in an engine running on service. In the case of the experimental engine it was ascertained that with the fuel-valve gland carefully packed (and tight) a force of 8.5 lb. was required to overcome gland friction (diameter of valve spindle, 7/16 in.). This should be regarded as being about the minimum figure. It will be seen that the 618-lb. spring provides only a small margin to overcome an increase in gland friction, or an increased fuel-oil pressure beyond that for which the system was originally designed. So far as spindle friction is concerned, the use of a "ground" fuel-valve spindle is an advantage—as a gland is then unnecessary. Difficulties following the adoption of higher pressures can be surmounted by fitting stronger springs or by a further modification of the design.

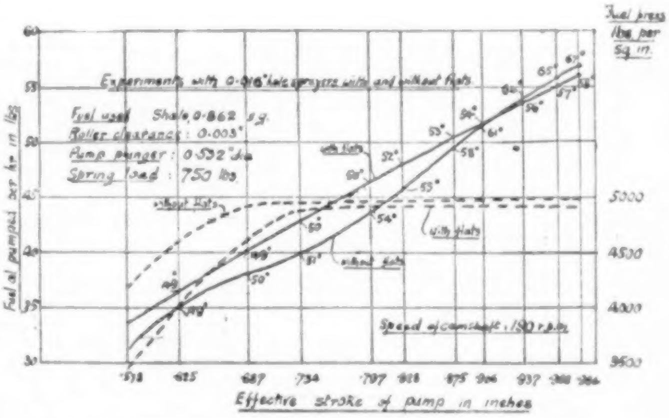

FIG. 2 EXPERIMENTS WITH SPRAYERS OF DIFFERENT LENGTHS

Some interesting experiments were carried out with the object of ascertaining the effect of reducing the lengths of the holes in the sprayer on the quantity of fuel oil pumped and also on the pressures reached in the system. For this purpose a special apparatus briefly illustrated in the original article has been prepared. The tests were made and two sprayers drilled with five 0.016-in.-diameter holes, one fitted with flats in the vicinity of each hole, and the other without flats. The length of each hole in the sprayer with the flats is about $^1/_{32}$ in., or about half the length of the holes in the sprayer without flats.

The data of these tests are shown and plotted in Fig. 2, where the quantity of fuel oil pumped per hour (full lines) and the pressure in the system for each sprayer (chain-dotted lines) are plotted against the *effective* pump stroke—the fuel-valve spring being loaded to 750 lb. in each case. Against each recorded point is a number which represents the total period of opening of the fuel valve in degrees, obtained from fuel-valve lift diagrams. It will be seen that for the same effective pump stroke the quantity of fuel pumped is greater in the case of the sprayer *with* flats than in the case of the sprayer *without* flats, until the "jumping" of the fuel valve with the latter becomes excessive. It will also be seen that the fuel valve begins to "jump" when the pressure in the system exceeds about 4300 lb. per sq. in.

Similar experiments were carried out with these sprayers with a spring loaded to 900 lb. The effect of the stronger spring was to reduce the "jumping" of the valve with each sprayer, but the fuel pressures throughout were generally higher and the value of flats was more marked.

A large number of experiments were made with the sprayers under varying conditions, and the results may be summarized as follows:

1 It was noticed that the valve-lift diagrams obtained when the apparatus was barred round was shorter with a 900-lb. spring than with a 750-lb. spring—due to a slight deflection of the fuel shaft and lever at the increased spring load.

2 The difference between the quantity of fuel oil pumped when spraying into a cylinder filled with compressed air at 430 lb. pressure and when spraying, with the same sprayer, into the atmosphere was inappreciable.

3 When pumping the same *weight* of fuel oil, other conditions remaining the same, the pressure in the system when using Broxburn oil of 0.816 sp. gr. was slightly less than when using shale oil of 0.862 sp. gr.

4 It was thought that there might be a slight difference in the results with sprayers drilled with twist drills and similar sprayers drilled with flat drills. Two sprayers were therefore made similar in all respects, but the holes in one were drilled with flat drills 0.155 in. in diameter, and in the other with twist drills 0.01575 in. in diameter. The sprayers when tried in the spraying apparatus did not indicate any difference in the amount of fuel oil pumped, nor was there any difference found in the fuel pressure in the system.

5 The spindle friction of the valve used in these experiments was 15 lb., i.e., the valve required a force of 15 lb. to draw it through the packing with the spring removed. (The previous figure mentioned was $8^1/_2$ lb.)

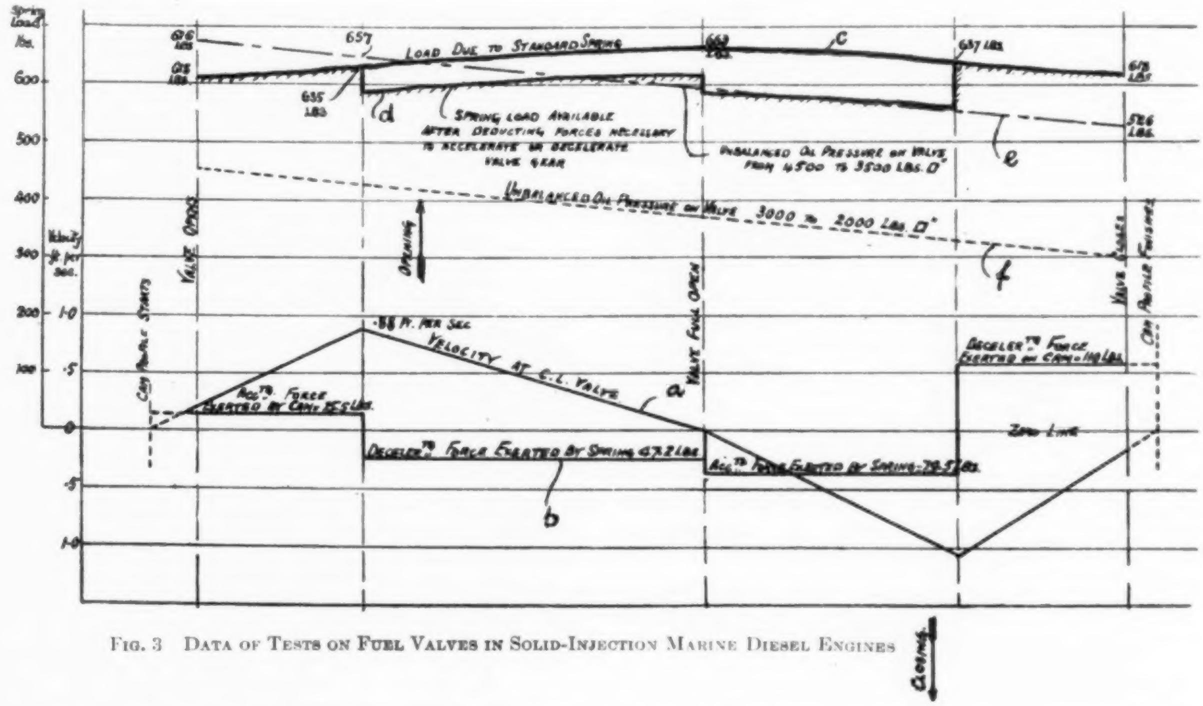

Fig. 3 Data of Tests on Fuel Valves in Solid-Injection Marine Diesel Engines

6 When the fuel pump was pumping with an effective stroke of $^{15}/_{16}$ in. against atmospheric pressure only its volumetric efficiency was about 95 per cent. The volumetric efficiency when pumping against the maximum pressure averaged about 75 per cent.

The conclusion to which the author arrives is that the success of the solid injection in service from the point of view of smokeless combustion depends very largely on the fuel-valve and fuel-pump design, correct settings, clean sprayers, and tight joints in the system. The best all-around results were obtained with a sprayer provided with five holes 0.016 in. in diameter. In general, however, the number and size of the holes in a sprayer depend on the mean pressure in the fuel-injection system; on the viscosity of the fuel oil; on the mean indicated pressure aimed at; on the distance the jets have to penetrate into the combustion chamber and also on the speed of the engine. The angle of the holes, i. e., the angle of the cone on which the holes are drilled, is dependent on the shape of the combustion chamber. So far as the author is aware, there are at present no formulas which can be used to determine the number, size and angle of holes necessary in a sprayer for a given engine to insure the best results—it is largely a question of trial and error.

The second part of this extensive and interesting paper cannot be presented here owing to lack of space, but it will be abstracted in an early issue of Mechanical Engineering. (Paper read before the North-East Coast Institution of Engineers and Shipbuilders, Newcastle-on-Tyne, Nov. 26, 1920, abstracted through an advance publication, 44 pp., 28 figs., *eA*)

SURFACE CONDENSERS FOR NAVAL VESSELS

Surface Condensers, Luther D. Lovekin, Mem.Am.Soc.M.E. There was a time when condensers were designed on a basis of so many square feet of surface per horsepower and this practice is still followed in some cases, though it is undoubtedly an unsatisfactory basis of design.

Tests made by the author of this paper have shown that other factors have a very vital influence on the performance of condensers, in particular, velocities of water and the steam space surrounding the tubes.

Thus, in tests made with a $^5/_8$-in. tube placed inside of other tubes of varying inside diameter, heat transfers with varying velocities of water and different tube layouts were obtained varying from 1000 to as high as 2750, this latter having been obtained when ample steam space was provided between the tubes.

These experiments also showed that it was a serious mistake to fill up the condenser enclosure with an excessively large amount of tubes. Nothing could be gained by having the steam or condensed vapors traverse a mass of tubes after it had been condensed. Instead, the author recommended a design whereby a maximum inlet area between the tubes could be obtained so that with a volume of steam corresponding to a vacuum of $28^1/_2$ in., the velocity would be about 100 ft. per sec. or less. To do this, it was decided to reduce the depth of the bank of tubes to about half of that ordinarily used and to permit the condensate to be drained from said bank of tubes to its maximum temperature, approximately that of the temperature corresponding to the temperature of the vacuum.

An additional cooling chamber of liberal size was added to the condenser, the purpose of this being to condense any vapors that remained, the condensate from this area going into the common condensate space where it would be removed at the bottom of the shell. When used for battleships or the like, this air-cooling space was enlarged, providing about 40 per cent of the local tube surface. This enabled the outer portion of the condenser to serve as a primary condenser and the so-called air-cooling space as a secondary condenser. When the turbines are operating at less than full load, the primary condenser can do all the work and retain its heat in the condensate.

The design of the Lovekin condenser may be seen from Fig. 1. The air channel way is formed of two plates running the entire length of the space between the tube sheets, these plates being spaced apart and having their sides perforated with small holes over the entire plate. This is done so as to prevent any air pockets

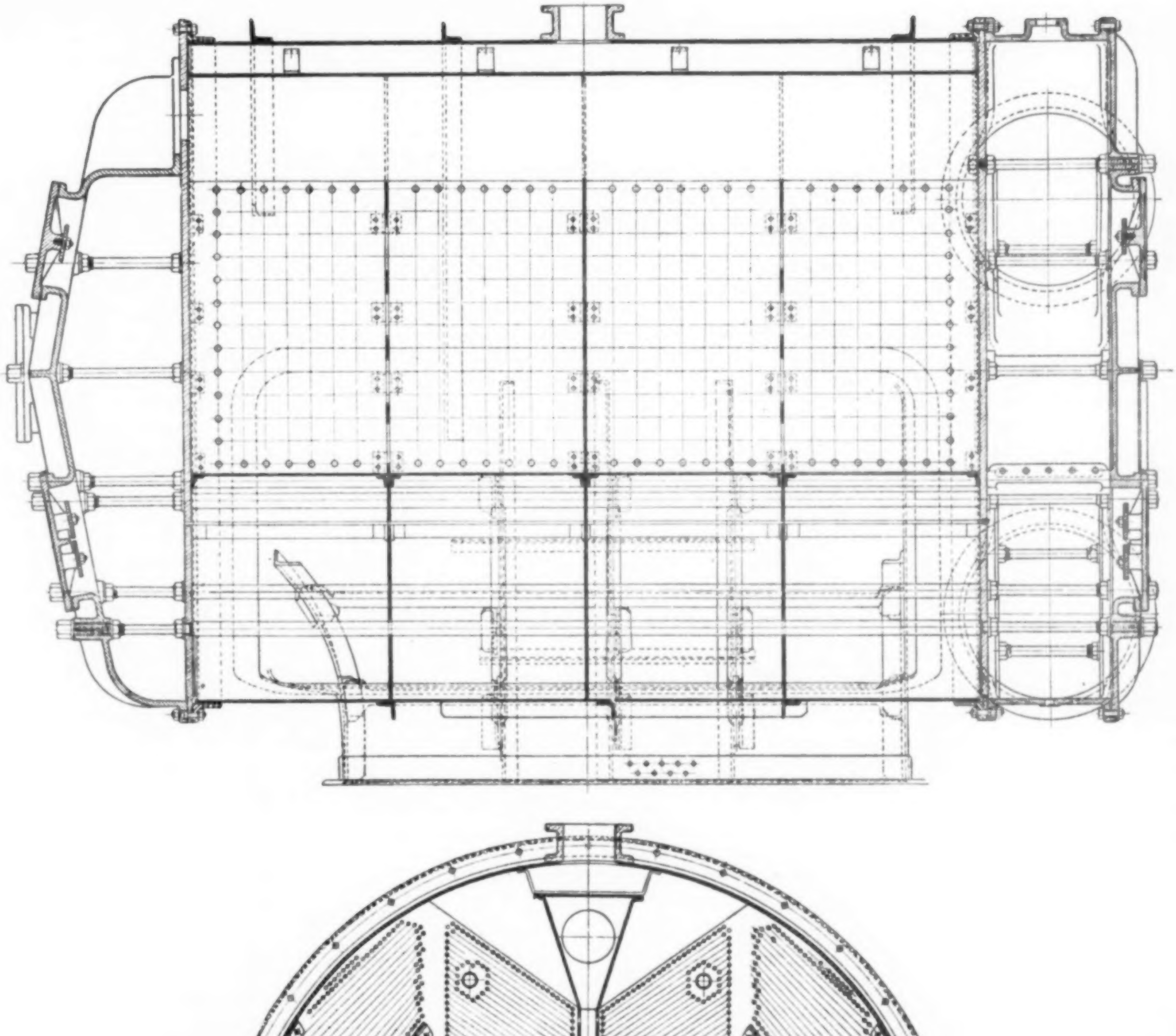

FIG. 1 LOVEKIN SURFACE CONDENSER

being formed in any part of the condenser. Where the condensate pump and air ejectors are used, the condenser head is cut away so as to clear the air-ejector connection. This makes a very simple connection and yet prevents the air pipe being flooded with water.

Small angle bars are placed in the lower edges of all the drain plates. These angle bars are not continuous but simply consist of short spaces with clear spaces of equal length between them so as to prevent the formation of a continuous sheet of water the entire length of the condenser running into the condensate space, which might interfere with the vapor and air entering the secondary zone.

In connection with the design of the Lovekin condenser, tests were made on the employment of coatings on the condenser shell as a means of preventing infiltration of air. These tests were made without any coating on the shell, then with one coat of bitumastic enamel, and finally with two coats of enamel. The effect of the final coat was an improvement of nearly 1 in. of vacuum under the same conditions. (Abstract of paper read at the 28th general meeting of the Society of Naval Architects and Marine Engineers, New York, Nov. 11–12, 1920.)

RIVETING FOR OIL-TIGHT WORK ON SHIPS

Notes on Rivets and Spacing of Rivets for Oil-Tight Work, Hugo P. Frear. The subject of proper riveting of oil tankers is a comparatively new one, as tankers themselves have scarcely been in existence fifty years. In fact, it is claimed that the first bulk oil-carrying steamer was built n 1872 in England.

Up to 1894 there were no definite rules laid for tanker construction by any of the national classification societies. In that year, however, Mr. B. Martell, chief surveyor to Lloyd's Register read a paper before the Institution of Naval Architects wherein he outlined his views on the details of construction and of riveting for bulk oil carriers. While not official, this paper served for a number of years as a guide to shipbuilders in the design and construction of tankers intended to be classed at Lloyd's. It is of interest to note, however, that the first rules of Lloyd's did not appear for general use until 1909, even though two other classification societies, the Bureau Veritas and the American Bureau of Shipping, had published their rules several years before. This is a good illustration of the slowness and care with which the great classification societies are accustomed to lay down their standards of construction.

In fact, judging from data presented in Mr. Frear's paper, it is doubtful if any standards of construction may be considered as having been definitely adopted even today. Thus, it would appear hat while double riveting is the general requirement for oil-tight work, single riveting is permitted in the seams of double bottoms intended for carrying fuel oil. It is still uncertain, however, whether single-riveted seams are tight enough for gasoline, or whether, as some claim, they are even more suitable for gasoline than for crude oil, because of their tendency to rust up with gasoline.

In this connection the writer recommends as well worth considering the use of single riveting in the longitudinal seams of center-line bulkheads, with the exception of the lower seam. The cargo is sometimes made up of more than one kind of oil and it is therefore important that the transverse bulkheads be absolutely tight, but different kinds of oil have seldom been carried on opposite sides of the center line and it would appear that a single-riveted longitudinal bulkhead would fulfill every function that the trade demands

As regards spacing, a considerable latitude still exists. At first, Lloyd's recommended three diameters for all oil-tight spacing, but a spacing of five diameters is now allowed in connecting bulkhead bounding bars to shell.

In both the types of bounding bars and the methods of riveting a variation is still permitted, the builder having an option of using either single double-riveted bars or double single-riveted bars. Furthermore, the rivets sometimes are calked before testing and sometimes are left free from calking. A good pan-head rivet should not require calking before testing. It would appear that countersunk-head rivets may require it.

Coming back to the subject of spacing, it would appear that while in his time Mr. Martell was justified in recommending a spacing of three diameters for satisfactory oil-tight work improvements in design, construction and workmanship have demonstrated that stanch ships can be built with wider spacing. In merchant vessels converted to carry oil the spacing is generally $4^1/_2$ diameters in the shell. In determining spacing it is well to bear in mind that work which might be tight under a static head might work loose on parts subject to the working stresses of a vessel in a seaway. Any design, spacing or workmanship which will not permanently prevent the joints from slipping will not remain oil tight.

In naval vessels using oil for fuel special problems of design came up. In these, in some cases, longitudinal bulkheadsare used as strength members and the riveting should be such as to obtain maximum strength, which means that the spacing cannot be made too close, especially where the bulkheads form boundaries of oil tanks. Because of this, if the strength bulkhead is designed for a spacing of six diameters for rivets in stiffeners and oil-tightness demands five diameters at the transverse bulkhead, it becomes necessary to introduce compensating liners which add to the weight and also increase the difficulty of making the structure tight. At the same time, tests carried out at the Philadelphia and New York Navy Yards appear to indicate that in fairly heavy plating where the members are not under the influence of other stresses than those due to head, six diameters is suitable. The thickness of angle bars, it was suggested, should preferably be not less than $^3/_8$ in. The Navy has under contemplation the revision of its rules for oil-tight riveting, due to the very considerable increase in amount of oil-tight work involved by new construc ion.

So far in naval work a c oser spacing is demanded for oil-tight work than for water-tight work, though experience in the construction of oil tanks in double bottoms seems to indicate that with ordinary good workmanship water-tight spacing will be satisfactory for oil.

The following spacing has been proposed as meeting both leakage conditions and the stresses imposed by deflections caused by calking and water pressure:

Plate	15-lb.	20-lb.	25-lb.	30-lb.	35-lb.
Spacing in diameters	4	4.5	5	5.3	5.6

These values, however, have been deduced without reference to strength of joint.

From the general data presented by Mr. Frear in his paper it would appear that any riveting for oil-tight work is really a compromise between the desire to produce an oil-tight joint and the very important consideration that every unnecessary rivet is a possible source of leakage and also a source of weakness of the plates. (Abstract of paper read at the 28th general meeting of the Society of Naval Architects and Marine Engineers, New York, Nov. 11–12, 1920.)

Short Abstracts of the Month

BUREAU OF STANDARDS

The Carbonization of Lubricating Oils. The principal reason for writing this circular was to give detailed descriptions of the methods used for the determination of the "Conradson carbon residue" and the "Waters carbon" of oils used to lubricate internal-combustion engines.

After brief accounts of the nature and effects of "carbon" deposits in the engine, and of the chemical nature of petroleum oils, the theories concerning the causes of the deposition of this material are discussed in connection with somewhat detailed accounts of the oxidation and cracking of petroleum oils.

The Waters and Conradson tests are described in detail, together with the apparatus employed, and brief accounts are given of a few other methods, including those in which the oil is distilled.

The circular closes with a condensed summary of several more or less controversial papers that have been published elsewhere. (Abstract of Circular No. 99 of the Bureau of Standards, e)

ENGINEERING MATERIALS

WIRE ROPES RESEARCH. Report issued by a Committee of the Institution of Mechanical Engineers covering experimental research on wire ropes for use over pulleys.

It does not appear that the Committee carried out any special experimental work of its own, but it very carefully collated all the available information and presented it in a clear form.

The conclusions arrived at are that there is no reliable information available as regards the factor of safety when used over pulleys. No sufficient data are available to establish a general method for the design of ropes, especially as entirely different problems present themselves in various installations. Thus, the outside wear is most important for a rope working on a large pulley, whereas bending fatigue and internal wear do most damage when a small sheave is used.

The calculation of the bending stress for design does not at present appear to be satisfactory. There is a lack of agreement on the factor to be used with the Reuleaux formula. There is no rational formula which covers the actual conditions and it has not yet been shown that the bending stress is the determining factor in the destruction of a rope. It is suggested that an attempt should be made at an analysis which will separate the three destructive effects: namely, outside wear, wear between the wires, and bending fatigue.

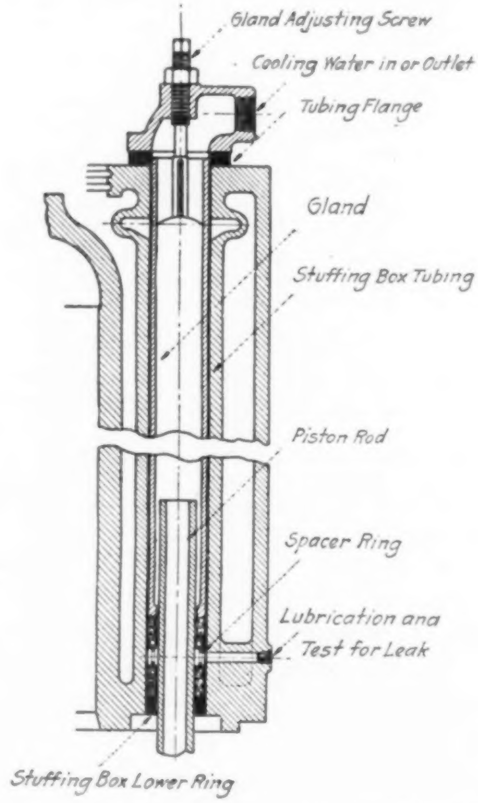

FIG. 1 SECTION THROUGH POWER CYLINDER OF THE MANNING, MAXWELL & MOORE MARINE DIESEL ENGINE

Distinction should be drawn between hardness and tensile strength, which are generally regarded as increasing together.

The information concerning the wire diameter indicates a difference of opinion which was not expected. As regards the adjustment of the lays to suit the diameter of the pulley, some writers have asked for it, but there is no exact information which bears on this point. The balance of opinion favors Lang's lay, where it can be used, but the preference is not shown so clearly by American engineers.

The effect of different angles of bending of the cable over the pulley appears to be explained very clearly by Leffler, although some opinions are at variance with his conclusion. The formula he gives to calculate the true radius of curvature of the rope does not agree with that of the Trenton Iron Company.

The report points out the scarcity of experimental data and gives the impression as if in the field of wire rope for use over pulleys there is scarcely a single element of design on which sufficient information is available and an agreement exists between engineers. To say the least, this is a very surprising state of things, considering the extensive and long use of such wire ropes. (*The Journal of the Institution of Mechanical Engineers*, no. 7, Nov. 1920, pp. 835–868, 1 fig., *gpA*)

INTERNAL-COMBUSTION ENGINEERING

Marine Diesel Engine with Peculiar Arrangement of Scavenging Pump and Piston Rods

GOLDBERG DOUBLE-ACTING TWO-CYCLE MARINE DIESEL ENGINE. Description of an engine in which the scavenging pump is in two stages, the first stage serving for scavenging proper and the second stage for supercharging the working cylinder and also as the first stage for the injection-air compressor. With this arrangement the low-pressure injection cylinder requires not over 70 per cent over its displacement when using air at atmospheric pressure. The air-pump piston closes the scavenging ports ahead of its dead center for a distance, preventing the pump on its return stroke from filling again from the working cylinder.

This means that the scavenging port of the pump cylinder is not uncovered again until the working piston has covered the the scavenging ports of the power cylinder.

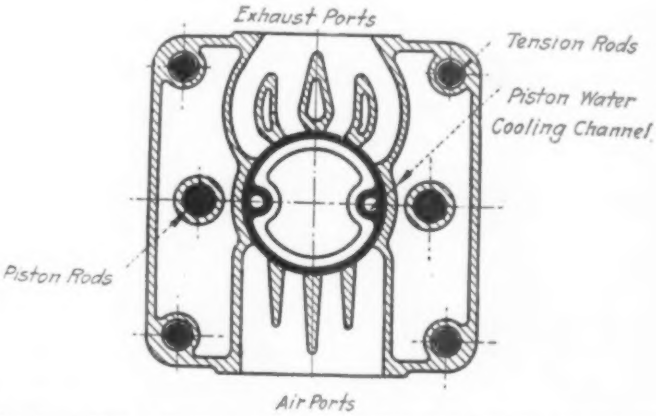

FIG. 2 A LARGE SECTION OF STUFFING BOX FOR PISTON-COOLING ARRANGEMENT, MANNING, MAXWELL & MOORE MARINE DIESEL ENGINE

To provide a better cooling of the pistons, the piston rods are extended into the upper cylinders and are drilled as shown in Fig. 1, one rod serving for water intake and the other for water outlet. The stuffing boxes proper for these sliding pipes (Fig. 2) consist of a light tubing with a collar at the bottom extending to the lower end of the cylinder casting. The packing is held between the lower collar and the gland in the form of a tube.

It is claimed that the double-piston-rod arrangement besides other advantages accomplishes also a great saving in the construction of the connecting rods. With this, the crosshead proper consists of a simple steel forging to which the crosshead shoes are fastened in a conventional way, but the forked type of marine rod is not used any more.

The four-cylinder 3000-shaft-hp. engine of this type has the following dimensions:

Bore	22 in.
Stroke	33 in.
Speed	120 r.p.m.
Piston speed	660 ft. per min.
Shaft mean effective pressure (m.e.p.)	66 lb. per sq. in.
Overall length, including flywheel, thrust block and air compressor	40 ft.
Overall height from center line of shaft	26 ft.

A shaft m.e.p. of 66 lb. per sq. in. is a very conservative figure. The low piston speed of 600 ft. per min. was selected with propeller efficiency in view. A shaft m.e.p. of 66 lb. per sq. in. can be obtained without surcharging the cylinders and the great over-

load capacity of this type of engine for forced runs of vessels may well be of great value. With surcharging and increasing the speed of the engine, say, to about 160 r.p.m., we can obtain 3000 shaft hp. for short periods, though it may not be advisable to carry this load through continuous days of service. (*Motorship*, vol. 5, no. 11, Nov. 1920, pp. 993–994, 3 figs., *d*)

FUELS AND FIRING

Initial Air Temperature and Economy of Furnaces

Influence of the Initial Air Temperature on Combustion Processes in Furnaces, J. Hudler. The question of the importance of higher initial temperatures of air supplied to furnaces is discussed and it is pointed out that this importance is much greater than is generally realized. Particular attention is paid to the relation between the entering temperature of air and the temperature of exhaust gases and rate of firing of the unit. In general, the problem of firing consists in the transmission of heat from rapidly moving gases of combustion to stationary solid or liquid bodies. The author claims that the processes taking place during this heat exchange are not always fully understood, and proves mathematically that to each initial temperature of air T_0 there corresponds a definite temperature of the exhaust gases T_1, providing the amount of heat generated per hour remains constant.

To show the bearing of this fact he compares two cases of combustion of pure carbon with a 6 per cent carbon dioxide content in one case and 12 per cent in the other, which corresponds to the change that occurs in passing from hand firing to automatic stoking with the better control of stack gases, and shows that if the rate of firing in the case of the 12 per cent CO_2 content be reduced to such an extent that the temperature of exhaust gases falls to 185 deg. cent., there will be a saving of 28.3 per cent in fuel, with undiminished output. Should, however, the gain in the CO_2 content be obtained by the usual method of decreasing the volume of exhaust gases, that is, maintaining the temperature of the smokestack constant, there will be a fuel saving of only 21.3 per cent. From this it would appear that the importance of higher content of carbon dioxide in the smokestack gases accompanied by a higher initial air temperature is greater than generally realized.

As to the means for securing a higher initial air temperature, the author points out that the heat contained in a cubic meter of exhaust gases must be considered as the basis for the initial temperature of the air and is fairly well proportional thereto, and therefore economically it is important to make the ratio W/V of heat in the air to heat in the exhaust gases as large as possible.

While such a requirement, however, is very simple theoretically, it is very difficult to solve the practical problems involved therein. In hand-fired grates immediately after the coal has been thrown upon the grate there is a development of gases with very high heat content which require large amounts of air for their combustion. As soon, however, as the process of volatilization is ended, and from that point on to the next firing, the air demand falls off. This difficulty is largely eliminated by modern automatic methods of firing in which coal is delivered on to the plate uniformly, and the air delivery may be maintained in a balanced manner proportional thereto. It is this that makes it possible to raise the content of carbon dioxide in the exhaust gases to 12 and even 14 per cent, which is so largely in excess of what could be done with hand firing. A still further opportunity to increase the content of carbon dioxide or to reduce the volume of exhaust gases is offered by producer-gas firing. While this method of firing has not proved hitherto entirely successful for boiler-operation purposes, this was mainly due to the fact that gas producers have considerable radiation losses which are further increased during the transit of the gases from the producer to the firing chamber, so that the reduction of V is offset by a simultaneous decrease in W. Furthermore, the usual addition of steam to the gas-producer air supply also increases V. It is therefore not correct to say that in view of fuel conservation our fuels should be utilized always in a gaseous state.

On the other hand, where producer-gas firing is used for purposes making necessary the employment of high smokestack temperatures, it is possible to raise the initial air temperature to a very high degree by preheating it, and therefore to increase the numerator in the expression W/V while maintaining the denominator unaltered.

The author asks the following question:

What gain is secured in preheating the air to 800 deg. cent. as compared with combustion carried on with air at zero deg. cent., maintaining the smokestack temperature at 1000 deg. cent. and operating with a 20 per cent excess of air?

The answer obtained is so surprising that it appears to be worth while to reproduce the calculation given in the article.

As during the combustion of one cubic meter of carbon monoxide 3046 kg-cal. are developed, the lower heat value of the gas is given by the expression

$$H_u = 3046 \times 0.347 = 1057 \text{ kg-cal.}$$

The combustion with the theoretical minimum of air produces 0.347 cu.m. carbon dioxide plus 1.306 cu.m. nitrogen. With an excess of air of 20 per cent there is added to this 0.261 cu.m. nitrogen and 0.069 cu.m. oxygen, which bring the total volume of exhaust gases to 1.983 cu.m.

The heat carried off by the exhaust gases is

$$W_R = 1000 \times (0.347 \times 0.501 + 1.636 \times 0.325) = 706 \text{ kg-cal.}$$

which means that the useful heat with cold air is equal to the initial heat of the gas (1057 kg-cal.) less the smokestack losses (706 kg-cal.) or to 351 kg-cal.

One cubic meter of gas, however, contains 1057/1.983 or 533 kg-cal., which gives an initial temperature of 1464 deg. cent.

On the other hand, with preheating of air we find that instead of the theoretical volume 0.826 cu.m., we have an increased volume of 1.156 cu.m. When preheated to 800 deg. cent. the heat content of this volume is

$$W_L = 1.156 \times 800 \times 0.32 = 296 \text{ kg-cal.}$$

which means that 1.983 cu.m. of smokestack gases carry the initial heat of 1057 kg-cal. and the heat added by the preheating of the air 296 kg-cal., or a total of 1353 kg-cal., equal to 682 kg-cal. per cu.m. of gases, which gives an initial temperature $T_0 = 1812$ deg. cent. It would appear, therefore, that for a temperature of preheating $t = 800$, the following equation expresses the conditions of equal output with and without preheating:

$$\frac{1464 - 1000}{l(1464 - 800) - l(1000 - 800)} = \frac{1812 - T_1}{l(1812 - 800) - l(T_1 - 800)}$$

from which T_1 can be found to be equal to 894 deg. cent. and

$$W_R = 894 \times (0.347 \times 0.504 + 1.636 \times 0.32) = 632$$

which gives the starting result, namely, that the useful heat is $1353 - 632 = 721$ kg-cal., or some 370 kg-cal. more with air preheated to 800 deg. cent. than with air at zero deg. cent., notwithstanding the fact that through preheating only 296 kg-cal. have been added.

In other words, the calculator shows that the increase in usefully employed heat is equal to 125 per cent of the increase of the heat content of the air.

Because of the fact that the initial air temperature has been raised, the smokestack temperature has been reduced and with it the smokestack losses have been reduced. The contention that the increase in efficiency produced by preheating the air of combustion is more than equivalent to the direct effect of the heat supplied to the air, is claimed to be a novel one, and it is further claimed that the same results are obtained if not air but the gas is preheated. From this point of view it can be seen how undesirable results are introduced by the usual cooling of gases in ammonia by-product recovery producers, apart from the fact that the large volumes of steam usually present in producer gas also act in the way of reducing the gas temperature and increasing the volume of the stack gases.

Other parts of this interesting article may be abstracted at a later date. (*Zeitschrift des Vereines deutscher Ingenieure*, vol. 64, no. 40, Oct. 2, 1920, pp. 810–814, 1 fig., *tA*)

MACHINE PARTS

Factors Affecting the Real Stresses in Helical Springs

HELICAL SPRINGS, W. Norman Thomas. It has been observed that in practice many springs fail under smaller loads than those for which they were originally designed. Investigation shows that there are two considerations which may easily be overlooked in the design and use of a spring, namely, (1) the effect of eccentricity of the load, and (2) the effect of the direct shear stress as distinct from the torsional shear stress in the material of the spring. Failure may be due either to entirely overlooking these two points, or, more often, to underestimation of the magnitude of the applied loads and of the effects of impact and repetition of stress. In a considerable number of cases failure may be due to the fact that the springs were designed for normal-temperature work and then afterward employed under very high- or very low-temperature conditions.

Equations are developed for the design of close-coiled springs and open-coiled helical springs, and curves are given, among other things, showing the bending and twisting moments in various parts of springs for different eccentricities of load, and the maximum principal stress and the maximum shear stress at the extremities of the vertical diameter of the cross-section of the wire. From these equations it appears that for the same value of M (eccentricity) the deflection is smaller with an open-coiled spring

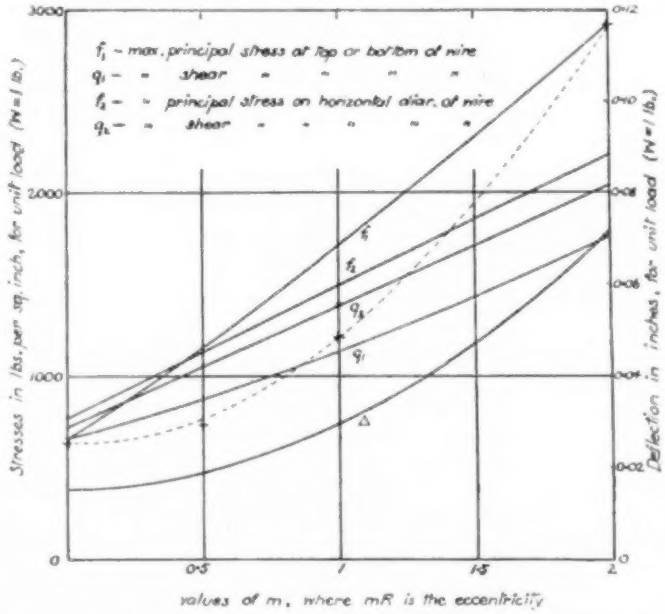

FIG. 3 GRAPHS OF STRESSES IN THE WIRE OF HELICAL SPRINGS CALCULATED BY VARIOUS FORMULAS

than a close-coiled spring containing the same length of wire. If the number of coils is the same for each spring, then for the same value of M the deflection is greater with an open-coiled spring than with a close-coiled spring. In addition to this, the values of the stresses in the wire calculated by the various formulas given in the article are tabulated and plotted in Fig. 3. From these it would appear that unless the load is axially applied upon a spring, the stresses may be considerably greater than those for which the spring was designed.

Thus, in an example worked out in the original article, 665 W would represent the load for which the spring was probably designed, that is, assuming axial loading and neglecting the direct shear stress; whereas the maximum shear stress even with axial loading is 721 W, and the maximum principal stress f_2 is 779 W.

With an eccentricity of $0.5R$, which could easily occur, the maximum shear stress is about 1053 W and the maximum principal stress f_1 about 1168 W.

If the eccentricity of the load is greater than $0.5R$ the stresses are still more in excess of the nominal safe load for axial loading. It is very important, therefore, that the ends of springs should be so designed as to insure axial loading. This is moderately simple for tension springs, but compression springs present more difficulty; unfortunately, too, the deformation of a spring under an eccentric compressive load tends to increase the eccentricity, and therefore still further to increase the stresses.

Some experiments were undertaken in order to test the truth of the general formula for deflection obtained in the original article, and they have generally confirmed it. (*Journal of The Institution of Mechanical Engineers*, no. 7, Nov. 1920, pp. 869–889, 13 figs., *tpA*)

MEASURING APPARATUS

Measuring Lengths to Within 1200 of a Millionth of an Inch

THE ULTRA-MICROMETER. Prof. R. Whiddington. Not so long ago working "to a hair's breadth" was considered quite an achievement. Then, the thousandth of an inch became a fairly common limit of precision in machine work, and a thousandth of an inch is only a fraction of a hair's breadth. It had been found, however, that in order to permit work to a thousandth

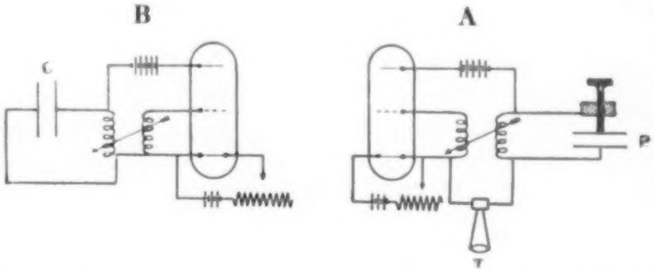

FIG. 4 DIAGRAM OF MAIN ELECTRICAL ELEMENTS IN THE WHIDDINGTON ULTRA-MICROMETER

of an inch the gages had to be made far more precise, and various methods, in particular the so-called interferometer methods of measurement, were developed, permitting a precision as high as one-millionth of an inch.

Interferometer methods, however, are limited in accuracy of measurement by the wave lengths of light used in the production of the images. It is not always easy to see at once where precision of measurement in excess of a millionth of an inch may be required, but in scientific work there are already cases where a higher precision is desirable. The ultra-micrometer, a new device, permits measurement to the scarcely creditable precision of one two-hundredth of a millionth of an inch. As an idea of what one two-hundredth of a millionth part of an inch means, it may be said that it bears very roughly the same relation to one inch that one inch bears to the distance by rail between New York and San Francisco.

The new measuring apparatus is based on the fact that if an electric circuit, consisting of a parallel-plate condenser and inductance, be maintained in oscillation by means of a thermionic valve, a small change in distance between the plates produces a change in the frequency of the oscillations which can be accurately determined by certain methods. The sensitiveness of the apparatus is extremely high.

The theory of the method is comparatively simple. If a capacity C be connected to an inductance L, the frequency of oscillation N natural to the circuit is given by

$$N = \frac{1}{2\pi\sqrt{LC}}$$

If the condenser be composed of two parallel plates of area A separated by distance x, then the capacity C is determined by the equation

$$C = \frac{A}{4\pi x}$$

If we substitute this value C into the above equation for N, we obtain

$$N = \left(\frac{x}{\pi LA}\right)^{\frac{1}{2}}$$

which shows that a change in distance x between the plates pro-

duces a change in the frequency of oscillations N, so that inversely a change N may be taken as an indication of a change in x.

On the basis of this theory was built the apparatus shown in Fig. 4. In this diagram A is the oscillating-valve circuit involving a parallel-plate condenser P; T is a loud-speaking telephone, shown for simplicity directly inserted in the valve-anode circuit, although in actual practice an amplifier intervenes.

The values of the coils in the grid and anode circuits of the thermionic valve were so chosen as to produce oscillations N of about a million frequency. In order to bring about any change in N a second valve circuit B was set up close to the circuit A. The frequency of this circuit could be adjusted by means of the condenser C so as to be nearly but not quite equal to N. This produced a loud audible note in T, the frequency of which could be adjusted to any desired value by a suitable choice of C. Another valve circuit was provided with proper capacities and inductance in order to provide a constant standard of pitch to which the note in T could be adjusted. This additional circuit is now shown in Fig. 4.

As regards the sensitiveness of the apparatus, it may be mentioned that the bending of a very substantial table, produced by an English penny coin laid on its edge, was clearly indicated by a change in the note from the telephone T.

The details of the method of measuring are not given. The method has been of service, however, by proving that Hooke's law was obeyed to the limits of accuracy set by a micrometer capable of measuring to 10^{-4} inch. (*London, Edinburgh and Dublin Philosophical Magazine and Journal of Science*, vol. 40, no. 239, Nov. 1920, pp. 623–639, 2 figs. and 1 plate of photographs, *dA*)

METALLURGY

New Method of Carbonization. Earl W. Pierce and John W. Anderson, Mem.Am.Soc.M.E. In this article the authors question whether the conventional method of carbonizing produces a tough core. They claim that the hardening of the outer wearing surface is produced at the expense of the core.

The treatment which they recommend to avoid this disadvantage is based on the idea of keeping the carbonizing temperature as near the first hardening heat as possible, or vice versa.

The method requires a lowering of the carbonizing temperature close to the core-refining heat, as it would not be practical to raise the hardening heat to the carbonizing temperature without danger of ruining the part. This method makes a longer carbonizing time necessary to produce the necessary depth of case, but this increased time is made up in the subsequent hardening heats.

Actually, the process is carried out in the following manner: The carbonizing temperature is lowered to that of the core-refining heat, namely, to 1600 deg. fahr., so that the carbonizing is carried on well within the carbonizing zone and at the same time at a temperature insuring as fine a grain as possible. When the work has become heated through at this temperature, it is quenched and the fine structure formerly produced in the carbonizing operation is trapped. It is well to hold the heat at the hardening temperature a few minutes to recover any crystalline growth which may have occurred in cooling after carbonizing between that temperature and the upper critical point of this kind of steel, which is about 1550 deg. fahr.

It is claimed that this method permits straightening with ease work distorted to some extent in hardening, and with practically no breakage loss nor cracking of the case-hardened surface. (*The Iron Age*, vol. 106, no. 21, Nov. 18, 1920, pp. 1315–1316, *dp*)

Important work is being done in the field of metallurgical applications of the so-called rare metals. During the war zirconium is said to have been extensively used in gun steel, as it imparts an increased hardness to the metal. In this country apparently successful attempts have been made to use cerium as a deoxidizer for cast iron. No metallurgical applications have yet been discovered for barium, strontium and beryllium, while lithium is used only sparingly in one or two special alloys.

MOTOR-CAR ENGINEERING

Steam Power Plants as Applied to Vehicles for Common Roads. F. L. Egan. Discussion of the application of steam power to motor vehicles, in particular passenger cars and trucks and covering English and American practice.

From data presented in the article it would appear that substantial progress in the direction of application of steam has been achieved in England where the high cost of gasoline makes the use of cheaper fuels with steam more attractive than in this country.

The two following facts are presented in reference to the practice of a large company operating motor buses in London. Although the company formerly operated gasoline- and kerosene-engine buses, it is regularly replacing the gasoline units with steam machines. Furthermore, in 1915, on steam-driven machines a change was made from kerosene to coke fuel, sufficient coke for about 50 miles being carried.

The larger part of the paper is devoted to the description of the Stanley and Doble-Detroit systems. As regards the probable trend of future developments, the author believes that the steam-generation and combustion system will be simplified, and states that a distinctly new type of boiler made possible by a new application of combustion is now in the experimental stage.

The engine, in the opinion of the author, will stand practically as it is, except that for the larger trucks it may be advisable to use a separate engine to drive each rear wheel through an internal gear on the road wheel meshed into a pinion on the end of a short crankshaft, which would do away with differential-gear and live-axle troubles. (*Proceedings of the Engineers' Society of Western Pennsylvania*, vol. 36, no. 7, Oct. 1920, pp. 455–484, and discussion pp. 485–491, 23 figs., *g*)

FUELS AND FIRING (See Producer Gas)

INTERNAL-COMBUSTION ENGINEERING (See Producer Gas)

PRODUCER GAS

British Practice in the Operation of By-Product Plants for Power Purposes

Notes on Operating a By-Product Producer-Gas Plant for Power and Heating. Description of a plant built for the Hoffmann Manufacturing Co., Ltd., in England, and operating on the Lymn system. The plant is in two units of 30 tons capacity each and is intended to have by-product recovery.

In a plant of that character it is very important to prevent the destruction of ammonia, which means that large quantities of steam have to be introduced with the air into the producer; this has the effect of facilitating the formation of ammonia and preventing its destruction by keeping the temperatures in the producer comparatively low. From 2 to $2^1/_2$ lb. of steam per pound of coal gasified may be taken as an average figure, and the provision of so much steam is a serious item in the cost of production. In the plant described the method adopted is to cool the gases by contact with water and heat up and saturate the air with the hot water so obtained. The process is continuous and results in having approximately 0.75 lb. of steam picked up by the air for every pound of coal gasified, which corresponds to a temperature of 68 deg. cent. (154.4 deg. fahr.) saturation. The balance of steam required is obtained from a boiler plant in which a superheater is included for steam required in the plant for other purposes outside the gas installation. It was found, however, when superheated steam was used for the gas plant that the air was not saturated to the extent indicated by the thermometer. In order to obtain steadier operating conditions the pipe arrangement was changed and saturated steam used for the gas plant in place of superheated.

The introduction of highly saturated and comparatively cool air into the producer results in cooling the fuel bed below a good working temperature. To prevent this a regenerator is provided wherein the temperature of air and steam mixture is increased to about 220 deg. cent. before it enters the producers, the necessary

heat being obtained from the sensible heat of the hot gases leaving the producer.

Fig. 5 shows a diagrammatic view of a plant on the Lymn system. The air enters at the lower part of the No. 3 air washer, called the air saturator. The upper part of No. 3 is divided off by a diaphragm, the only connection between the two being through a water seal. The water which is made hot by contact with the gas in the upper part of the vessel passes through this seal into the air saturator and there meets the gas coming from the bottom of the vessel. The additional steam is blown into the air main between the air saturator and the regenerator (referred to in the figure as superheater), which consists of a nest of concentric cylinders so arranged that the hot gases from the producer and the saturated air pass in countercurrent. From the regenerator the hot gas is passed through a dust trap before it enters a vertical dust washer No. 1, in which the remaining dust is removed by water. From the top of the dust washer the gases pass down to the bottom of washer No. 2. In their upward flow through this washer they are brought into intimate contact with a solution of sulphate of ammonia containing a slight excess of sulphuric acid which absorbs ammonia from the gas. In the design of the Lymn washers no obstructions in the shape of packing boards or tiles and no moving parts are employed. The apparatus consists simply of several vertical cylindrical chambers, No. 1 of which is simply fitted with water jets at the top which fill the vessel with spray through which the gas passes in an upward direction and is thereby washed. Nos. 2, 3 and 4 contain a series of truncated cones axially placed in the center of the apparatus; a vertical shaft carries a number of fixed disks opposed to these cones. The water entering at the top is distributed on the topmost disk from which it flows in a film or sheet on to the surrounding cone, thence it falls on to the next disk and so on to the bottom of the washer. The gas passes upward, countercurrentwise, through the sheets of falling water. By this means the gas and the washing liquids are brought into intimate contact, with a minimum expenditure of energy.

In this instance the ammonia absorber was built of steel and the usual lead lining dispensed with. No particular corrosion was observed.

The gas, after leaving the final cooler No. 4, is passed through two Jenkins centrifugal gas cleaners and then through a water separator of the cyclone type, from which it goes into the gasholder, governor which is so arranged that in the event of the gas failing, the supply to the gas engines is cut off before that to the furnaces. This prevents any suction caused by the engine coming on the furnaces which might lead to an explosion should the gas come again suddenly. Gas intended for use in the engines is passed also through sawdust scrubbers to extract the last traces of tar. This proved to be necessary as the centrifugal-fan cleaners do not make the gas sufficiently clean for use even in furnaces, which in this instance are supplied through comparatively small pipes (down to $^3/_4$ in. in diameter). In large metallurgical furnaces where the burners are formed of refractory nozzles and the gas is conveyed in large pipes, the presence of small amounts of tar could not be detrimental.

As regards the power units, multi-cylinder horizontal Otto engines of about 500 b.hp. were selected, each gas engine being fitted with an exhaust boiler, the exhaust being connected to the boiler with a by-pass.

The original article contains extensive data as to the costs and operating results which would be of only minor interest in view of the fact that only British coals were used.

Careful inspection was maintained with respect to the possible corrosion of steel vessels, which in this case were not lead-lined. Practically no corrosion was observed which might have possibly been the result of the composition of the coal. The author's experience would lead one to believe that little corrosion takes place with mild steel unless the metal is also either subject to erosive action or is under stress.

In general, and as far as English conditions are considered, the author believes that low-grade fuel must be better utilized in the future than in the past. While not all coal will be either gasified or coked, there is every probability of much more coal undergoing one of these processes in the future than is the case at present. To what extent sulphate of ammonia recovery from fuel will pay will depend not only on the nitrogen content of the fuel and its price (together with cost of recovery, including capital charges), but also on the selling price of the sulphate, and this may be greatly affected by some of the processes of nitrogen fixation that have been so largely developed during the war. This last consideration is likely to have an important bearing on the adoption of a process for recovering ammonia from coal.

It may be of significant import that the writer claims the shortened week with only one operating shift as a most disturbing element in connection with power generation. The load factor is the most important element in cheap power and a high load factor is impossible with a short working week and only one shift working in the 24 hr. as this deprives the central station of the diversity factor which might make up for the short working hours employed by the consumers. (*The Journal of The Institution of Electrical Engineers*, vol. 58, no. 292, June 1920, pp. 417–430 4 figs., *d*)

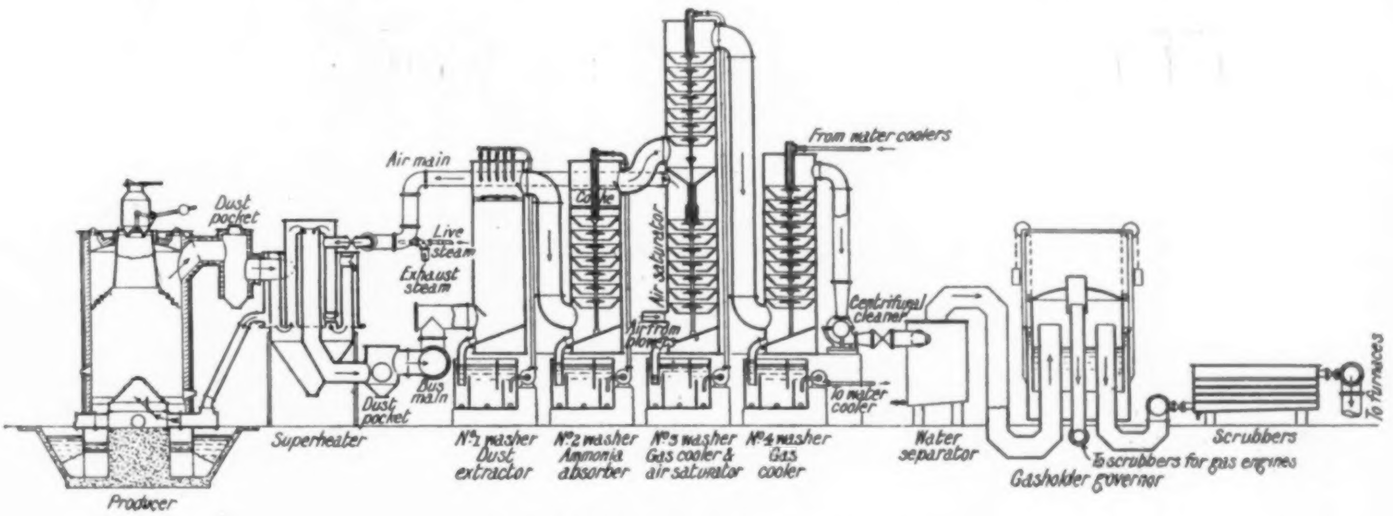

Fig. 5 Lymn Gas Plant, Sectional Diagram

REFRIGERATION

Ice Tank of New Design, C. Wilkie. Description of ice-freezing tanks installed in the Finney Avenue Plant of the Merchants' Ice and Coal Company, St. Louis, Mo.

During the season of 1919 it was decided to increase the capacity of the ice-freezing tanks in the plant, which could be done either by building a new tank or extending the old tanks. The latter

was much the cheaper plan but would make an excessively long tank, calling for a coil 1500 ft. long, provided the coil ran the full length of the tank.

The design finally resorted to called for a tank 114 ft. long, holding 856 cans freezing 400-lb. blocks. The general layout is shown in Figs. 6 and 7. In the first place, there is an expansion header made of 5-in. pipe and provided with nipples to receive

Agitation is produced by a single propeller designed on the theory that higher efficiency can be secured with a large unit than with very small ones. The propeller is 36 in. in diameter and has three steel blades. It has a blade-tip speed of 16 ft. per sec. and is located in the center of the tank. It produces 7 in. of agitation, or one inch to seven cans.

In the original article tables are given showing the performance

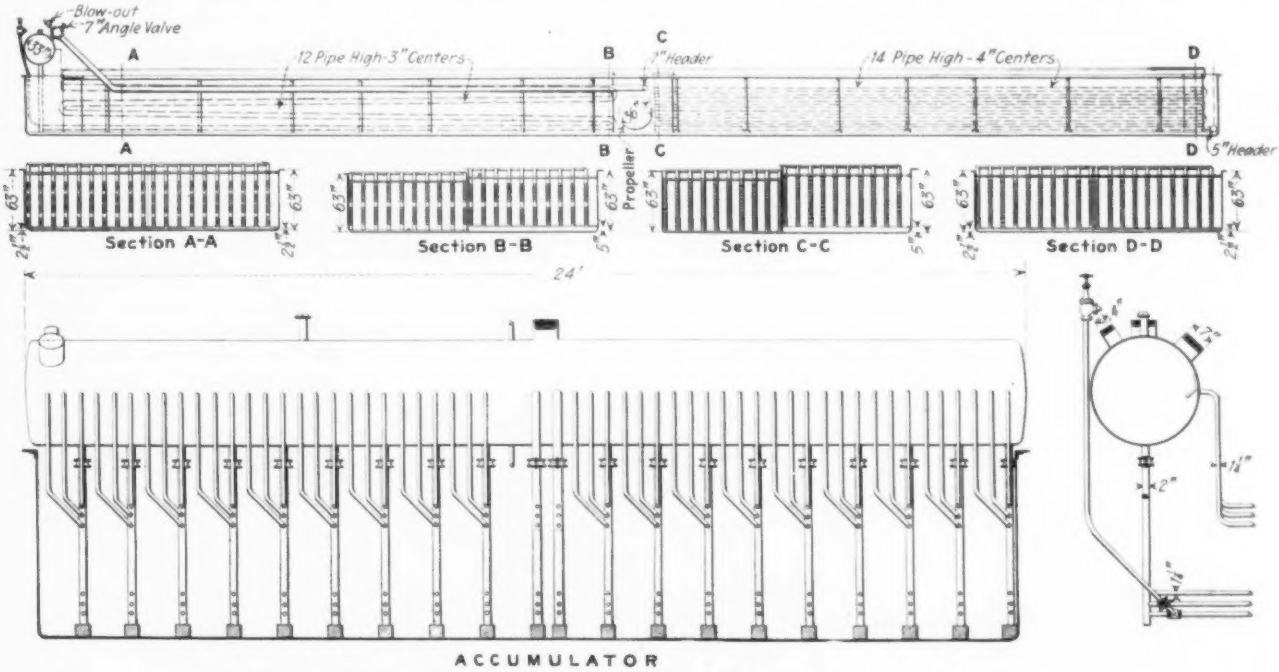

Fig. 6 General Layout of Ice Tank and Connections to Horizontal Accumulator

of the new tank as compared with those of the older tanks. The heat transmitted per degree temperature difference per square foot per hour in the old tanks was 25.8, while in the new tank it is as high as 40, which is about 60 per cent better than before.

There are several other features which cannot be described

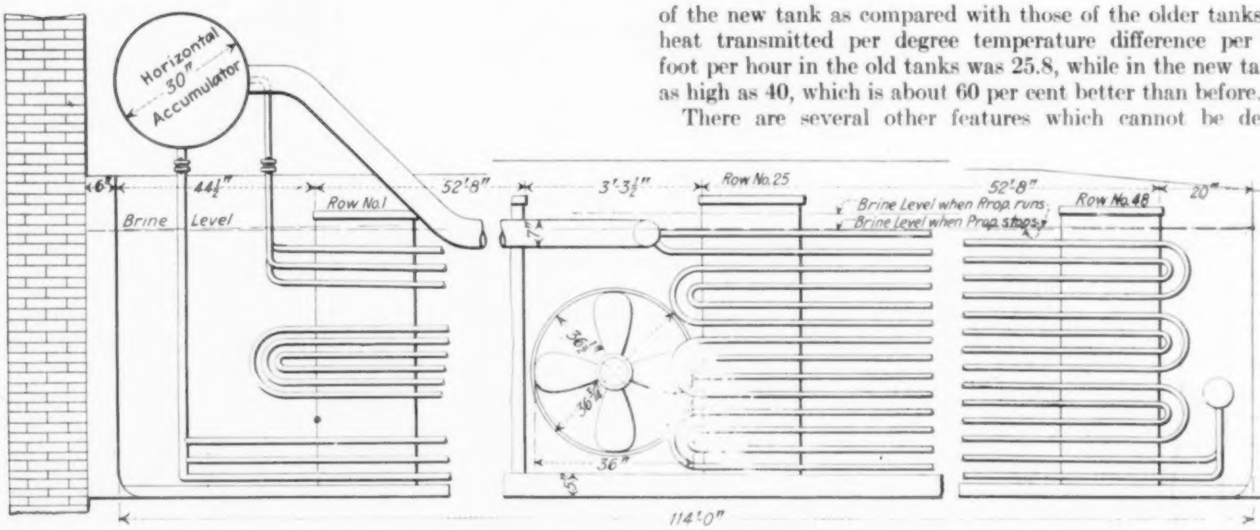

Fig. 7 Connection of Flooded Coils to Accumulator in Ice Tank

the two connections from each double coil. The header lies in the bottom of the tank and fits the two bottom pipes of each double coil, which gives an even ammonia feed for each coil as the head must be half full of liquid before any of the coils can receive any of it.

The whole tank is arranged so that direct-expansion coils are at one end and flooded coils with the horizontal accumulator at the other end. In the direct-expansion end of the tank the coils are double, that is, two coils in one; in the flooded end of the tank triple or three-in-one coils are used, each 220 ft. long. The liquid ammonia for the flooded end passes through the direct-expansion coils, then through the 7-in. line to the accumulator, thence by gravity feed into the bottom of the flooded coils, the gas passing from the coils back into the side of the accumulator above the liquid fuel (Fig. 6).

here for lack of space, such as the use of a special floor design, ...s, means for holding cans vertical, and interesting hoist- ...andling appliances. (*Power*, vol. 52, no. 21, Nov. 23, ... 823–826, 8 figs., *d*)

CLASSIFICATION OF ARTICLES

Articles appearing in the Survey are classified as *c* comparative; *d* descriptive; *e* experimental; *g* general; *h* historical; *m* mathematical; *p* practical; *s* statistical; *t* theoretical. Articles of especial merit are rated *A* by the reviewer. Opinions expressed are those of the reviewer, not of the Society. The Editor will be pleased to receive inquires for further information in connection with articles reported in the Survey.

ENGINEERING RESEARCH

A Department Conducted by the Research Committee of the A.S.M.E.

A Research Information Bureau

THE National Research Council has established the Research Information Service as a general clearing house and informational bureau for scientific and industrial research. This "Service" on request supplies information concerning research problems, progress, laboratories, equipment, methods, publications, personnel, funds, etc.

Ordinarily inquiries are answered without charge. When this is impossible because of unusual difficulty in securing information, the inquirer is notified and supplied with an estimate of cost.

Much of the information assembled by this bureau is published promptly in the "Bulletin" or the "Reprint and Circular Series" of the National Research Council, but the purpose is to maintain complete up-to-date files in the general office of the Council. Announcement will be made from time to time of special informational files which have been prepared.

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Research Résumé of the Month

A—Research Results

The purpose of this section of Engineering Research is to give the origin of research information which has been completed, to give a résumé of research results with formulas or curves where such may be readily given, and to report results of non-extensive researches which in the opinion of the investigators do not warrant a paper.

Apparatus and Instruments A1-21. Comparison of Electrical Instruments. The Bureau of Standards has recently coöperated in the comparison of the standards of the various laboratories of a large electrical manufacturing company. The instruments used for measuring current, voltage and power were carried from one laboratory to another and to the Bureau of Standards. The instruments were carefully checked against the working standards of each laboratory and showed a close agreement between the apparatus used in the various plants. The test also indicated that the different types of instruments tested maintain their accuracy under varying conditions of transportation Address Bureau of Standards, Washington, D. C., S. W. Stratton, Director.

Cement and Other Building Materials A1-21. Popping of Lime Plaster. An eight-page article is to appear in the *Journal of the American Ceramic Society* on the Popping of Lime Plaster, by Warren E. Emley and Cecil H. Bacon. The work was done at the request of Committee C-7 of the American Society for Testing Materials. Seventy-two specimens were made in the original series of experiments to determine the effect of underburned or overburned lime, the method of slaking, the quality of the sand and the presence of certain suspicious impurities. It was shown that the chlorides of sodium and magnesium, while they do not cause popping, cause serious discoloration. Another series of experiments showed that impure hydrate soaked overnight with water developed the usual buff color, but when soaked in an airtight container the color was green. This accidental discovery led to the suspicion of ferrous iron, which was confirmed. A third series of tests confirmed the fact that iron in the metallic, ferrous or ferric condition was quickly changed into the ferric condition, with consequent expansion and popping. The iron from the coal ash is apt to enter the lime in the methods usually employed in operating kilns. Other compounds from coal ash may cause trouble as compounds formed from lime and silica or lime and alumina will hydrate slowly when exposed to water and will expand as they hydrate. It is impossible to identify these compounds by means of analytical chemistry, and being in a colloidal state identification by microscope is difficult. Experiments were made by picking the centers out of pops and analyzing these chemically and microscopically.

The following conclusions are drawn:

1 The popping of a lime plaster is caused by the presence of grains of a material which hydrates slowly and expands as it hydrates.

2 This material may be a compound of calcium with silica, alumina, or iron, or it may be an incompletely oxidized salt of iron.

3 Such compounds may be introduced as impurities in the limestone, as ash from fuel, or as impurities in the sand.

4 When such impurities are uniformly distributed throughout the limestone, they will not cause trouble, even when the lime is overburned, if two precautions are observed: the hydrate should be screened through a No. 48 sieve and should be soaked overnight before using.

5 When the impurities occur along bedding planes on the stone, or as balls of clay adhering to the stone, or are introduced as ash from the fuel, they can be identified by the formation of a dark vitreous crust on the surface of the lime. All such lime should be discarded as unfit for plastering.

6 The sand should contain not more than 1 per cent of the chlorides of sodium and magnesium. Common clay, leaf mold, and similar impurities, do not cause popping. Ferrous carbonate and magnetite are apt to cause trouble if they occur in particles coarser than 48 mesh.

7 Referring only to these impurities which commonly occur in lime, it may be stated that those particles which are large enough to stay on a No. 30 screen will be almost certain to cause noticeable popping. Those which pass a No. 30 and are retained on a No. 48 screen may or may not be troublesome. These which pass a No. 48 screen will not cause noticeable popping, if the lime is soaked overnight before use.

8 Production of lime which will not pop may be assured by following these three precautions: (*a*) Reject all lumps of lime which are encrusted with vitreous material. (*b*) Screen all hydrate through a No. 48 sieve. (*c*) Soak all lime putty overnight before using it as a plaster.

9 Popping can be caused by impurities in the brown coat as well as in the finish coat. The above precautions should therefore be applied to both mason's hydrate and finishing hydrate.

10 The method of testing for popping now in use is fundamentally sound and gives satisfactory results. It is believed, however, that a requirement for fineness would be of greater value as a part of standard specifications for lime.

Address Bureau of Standards, Washington, D. C., S. W. Stratton, Director.

Glass and Ceramics A1-21. Ceramic Publications. The following publications dealing with ceramics have recently appeared:

1 The Rate of Vitrification of Porcelain Molded under Different Conditions, by R. F. Sherwood, in the October number of the *Journal of the American Ceramic Society.*

2 The Post-War Status of the Ceramic Industry, by A. V. Bleininger, *Chemical and Metallurgical Engineering*, Sept. 29, 1920.

3 Enamels for Sheet Iron and Steel, by Prof. J. B. Shaw, Technologic Paper 165 of the Bureau of Standards.

Address Bureau of Standards, Washington, D. C., S. W. Stratton, Director.

Metallurgy and Metallography A1-21. Bearing Metals. Experimental work on the compressive strength and hardness of white-metal bearing alloys at temperatures up to 100 deg. cent. has been completed and a paper has been prepared entitled Some Properties of White Bearing Alloys at Elevated Temperatures. The apparatus is described for determining the yield point and ultimate strength of white-metal bearing alloys. A new design of heating apparatus is described for determining the Brinell hardness of such metal under varying temperatures. The results of the compression test and the Brinell hardness are given for five typical white bearing-metal alloys, three tin-base alloys, one lead-base alloy, and one intermediate alloy. These tests show that the tin-base alloys maintain their properties better at elevated temperatures than those containing lead. Results indicate that up to 3 per cent the lead in a high-grade babbitt does not affect the yield point or ultimate strength at 25 deg. cent. or 75 deg. cent. The yield point of the tin-base alloy is not affected by heating for six weeks at about 100 deg. cent. The yield point of the lead-base alloy is lowered by heating for only two weeks at this temperature. Address Bureau of Standards, Washington, D. C., S. W. Stratton, Director.

Metallurgy and Metallography A2-21. Magnetic Properties of Eutectoid Steel. A simple carbon steel of eutectoid composition has been examined to find the effect of the rate of cooling on the magnetic properties and other properties of an annealed eutectoid carbon steel. A paper describing this investigation has been prepared. It was found that the magnetic properties are considerably influenced by variations in the rate of cooling from above the critical range and the corresponding variations are produced in the microstructure. There was an agreement between the values of the coercive force and the scleroscope hardness. Address S. W. Stratton, Director, Bureau of Standards, Washington, D. C.

Mining, General A1-21. Asbestos. Report Serial No. 2179, by Oliver Bowles, gives the usability of asbestos from South Africa. The material is found in Rhodesia, the Union of South Africa, Transvaal, Cape and Natal. Bureau of Mines, Washington, D. C. Address F. G. Cottrell, Director.

Optics A1–21. ULTRA-VIOLET RAYS. The effect of ultra-violet rays from arc-welding outfits on the human eye has proven very serious. Conjunctivitis is produced unless heavy lenses made up of alternate layers of red or blue glass or orange glass of sufficient thickness are used. When eyes are injured by these ultra-violet rays, treatment should be given under the care of a physician. The usual treatment is to use ice packs for 15 minutes to an hour three to four times a day, to irrigate the eye with a salt solution of one teaspoonful to a quart of sterile water or saturated solution of boric acid several times daily. With pus discharge a few drops of 25 per cent solution of argyrol should be used in the eye three times to six times a day. The patient should be confined in a darkened room. Pain may be so severe as to require the administration of morphine. Report by Dr. C. R. Kindall, Surgeon, Bureau of Mines. Address Bureau of Mines, Washington, D. C., F. G. Cottrell, Director.

Petroleum, Asphalt and Wood Products A1–21. EVAPORATION LOSSES FROM CRUDE OIL. Evaporation Losses from Crude Oil during Piping and Storage on Oil Leases is the subject of a report, Serial No. 2169, by A. R. Elliott. The results show that the evaporation depends on temperature and amount of disturbance to which the oil is subject. Open tanks will lose more oil on a cool, windy day than on a hot, still day. A gastight metal roof is better than one made of timber. The atmosphere above the oil in a tank is saturated with oil vapors. Under sun heat a temperature sufficient to distill the higher fractions from the oil is obtained. To maintain a low temperature a lagged or shedded tank should be used. A water-sprinkled tank painted white was proven to be most effective. This was followed by a water-sprinkled tank painted black, a glossy-white-painted tank, a water-topped tank, a black tank and an oil-stained, loose-wooded roof tank. The evaporation of gasoline from the crude oil amounted to from 5 to 25 per cent. Bureau of Mines, Washington, D. C. Address F. G. Cottrell, Director.

Railway Rolling Stock and Accessories B1–21. THERMAL STRESS IN STEEL CAR WHEELS. An investigation to determine the stresses in steel car wheels similar to that recently completed on chilled-iron wheels has recently been begun and tests on six wheels have been completed during the month of October. Address Bureau of Standards, Washington, D. C., S. W. Stratton, Director.

B—RESEARCH IN PROGRESS

The purpose of this section of Engineering Research is to bring together those who are working on the same problem for coöperation or conference, to prevent unnecessary duplication of work and to inform the profession of the investigators who are engaged upon research problems. The addresses of those investigators are given for the purpose of correspondence.

Agricultural Equipment and Engineering B1–21. WASTES. The recovery of valuable by-products from agricultural wastes in California is being investigated by the Beckman & Linden Engineering Corporation. Address J. W. Beckman, President, Beckman & Linden Engineering Corporation, Atlas Building, San Francisco, Cal.

Apparatus and Instruments B1–21. BOURDON TUBES. An investigation of the characteristics with a study of hysteresis effects of bourdon tubes, using an optical lever system for the exact determination of displacements under varying conditions. Bureau of Standards, Washington, D. C. Address S. W. Stratton, Director.

Automobile Vehicles and Equipment B1–21. WEAR OF AUTOMOBILE PARTS. Work for the Motor Transport Corps has been undertaken by weighing a number of bearings and gears on a sensitive balance, after which these are to be placed on cars in service. After a certain length of time these parts will be weighed. Address S. W. Stratton, Director, Bureau of Standards, Washington, D. C.

Cement and Other Building Materials B1–21. TERRA COTTA INVESTIGATION. The thermal expansion of seven different glazes and ten underslips is being determined from rods recently made. The therma expansion of clay specimens has been determined. The transverse strength is being investigated to determine the difference between pressed and cast terra cotta. The results on the transverse strength show that the glazed side does not have as great a tensile strength as the unglazed side of the terra cotta. Bureau of Standards, Washington, D. C. Address S. W. Stratton, Director.

Chemistry, Inorganic B1–21. MAGNESIA AND CARBON BLACK. Researches on the electrolytic production of magnesium and on the manufacture of carbon black are under way at the laboratories of the Beckman & Linden Engineering Corporation. Address J. W. Beckman, President, Atlas Building, San Francisco, Cal.

Electrochemistry B1–21. LEAD STORAGE BATTERY. A lead storage battery built on a new principle is being investigated by the Beckman & Linden Corporation. Address J. W. Beckman, President, Atlas Building, San Francisco, Cal.

Paints, Varnishes and Resins B1–21. FIREPROOF PAINT. The Glenn L. Martin Company is at work on tests of fireproof paint in connection with aircraft. Address L. C. Milburn, Assistant Chief Engineer, Glenn L. Martin Company, Cleveland, O.

C—RESEARCH PROBLEMS

The purpose of this section of Engineering Research is to bring together persons who desire coöperation in research work or to bring together those who have problems and no equipment with those who are equipped to carry on research. It is hoped that those desiring coöperation or aid will state problems for publication in this section.

Mechanics C1–21. STRENGTH OF TUBINGS. Data are required on torsional stresses induced in light-wall steel tubes from 1 in. to $2^1/_2$ in. O.D. and of Nos. 14 to 22 B.W.G. wall thickness. The stress determined by the formula $S = Pac/J$ is desired. Pa is the turning moment, c the distance from the neutral axis to the outside fiber and J is the polar moment of inertia. The curve in Fig. 1 shows the results acquired thus far. Address L. C. Milburn, Assistant Chief Engineer, The Glenn L. Martin Company, Cleveland, Ohio.

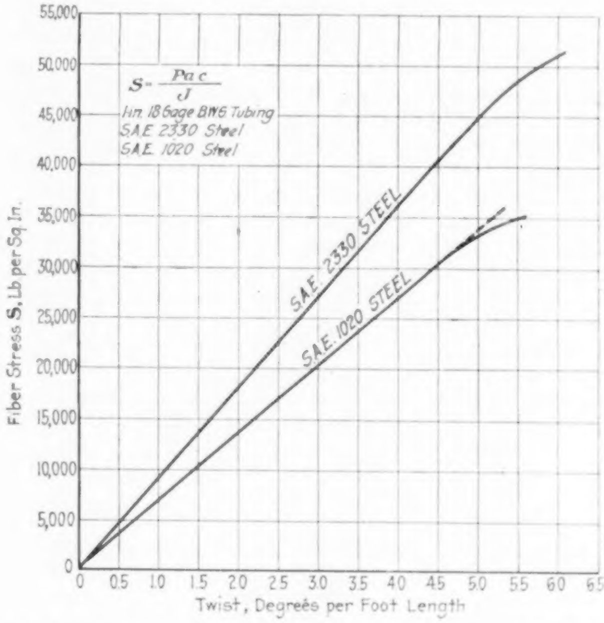

FIG. 1 RELATION BETWEEN TWIST AND FIBER STRESS IN 1-IN. NO. 18 B. W. G. STEEL TUBING

D—RESEARCH EQUIPMENT

The purpose of this section of Engineering Research is to give in concise form notes regarding the equipment of laboratories for mutual information and for the purpose of informing the profession of the equipment in various laboratories so that persons desiring special investigations may know where such work may be done.

Beckman & Linden Engineering Corporation D1–21. See *Beckman & Linden Engineering Corporation E1–21.*

Glenn L. Martin Company, Cleveland, Ohio, D1–21. The laboratory of this company consists of the usual chemical and physical departments. The Materials Testing Department includes one 50,000-lb. Olsen tension machine, one Erichsen sheet-metal testing machine, one pendulum-type combined testing and shock-testing machine, one rib-testing machine. Address L. C. Milburn, Assistant Chief Engineer, Glenn L. Martin Company, Cleveland, Ohio.

Metal & Thermit Corporation D1–21. The Research Laboratory of the Metal & Thermit Corporation is equipped with various types and sizes of furnaces, including reverberatory furnaces, smelting furnaces and muffles. Equipment for leaching, grinding of laboratory samples and for quantities used in manufacturing. The research equipment is divided into three classes according to size. The smallest is used in the laboratory and the largest in separate buildings devoted to research work. Address Mr. J. H. Deppeler, Chief Engineer, Thermit Dept., Metal & Thermit Corporation, 120 Broadway, New York.

E—RESEARCH PERSONNEL

The purpose of this section of Engineering Research is to give notes of a personal nature regarding the personnel of various laboratories, methods of procedure for commercial work or notes regarding the conduct of various laboratories.

Beckman & Linden Engineering Corporation E1–21. The laboratory has worked out successfully the separation of salts from natural brines and the production of various strontium and barium compounds from local ores. It has devised an efficient, cheap way of concentrating vinegar to a high percentage of acetic acid and has suggested economical utilization of various waste products of the rice industry. The laboratory is at work on the electrolytic production of magnetism, on a lead storage battery built on a new principle, on the manufacture of carbon black and on the recovery of valuable by-products from agricultural wastes in California.

The equipment of the laboratory is complete, but the laboratory would be glad to communicate with others working on the same problems. The laboratory is equipped with a furnace using 1000 kw., and a 15-kw. direct-current generator set gives a flexible range of voltages. Semi-commercial units are installed for extracting and distilling processes. Address J. W. Beckman, President, Beckman & Linden Engineering Corporation, Atlas Building, San Francisco, Cal.

Metal & Thermit Corporation E1-21. The research staff of the Metal & Thermit Corporation, 120 Broadway, New York, consists of about ten men, including the following:

Dr. E. A. Beck, from the Technical Universities of Munich and Aix-la-Chapelle. Dr. Beck worked on iron, steel, lead, silver, copper and zinc. In 1908–1909 he worked with the Roechling Iron and Steel Works, using the electric furnace. In 1910 he worked for the American Smelting and Refining Company and the American Vanadium Company. Since 1911 he has worked with the Metal & Thermit Corporation.

Mr. S. Lubowsky (B.S. and Ch.E.), Carnegie Institute of Technology 1913, Ch.E. in 1917. Formerly Chief Chemist, Reduction Works, Crucible Steel Company of America.

Mr. L. C. Mazzola, B.Sc. Cooper Union, 1917. Worked with the Dexola Chemical Company and the Wright-Martin Aircraft Corporation.

F—Bibliographies

The purpose of this section of Engineering Research is to inform the profession and especially the members of the A.S.M.E. of bibliographies which have been prepared. These bibliographies have been prepared at the request of members, and where the bibliography is not extensive, this is done at the expense of the Society. For bibliographies of a general nature the Society is prepared to make extensive bibliographies at the expense of the Society on the approval of the Research Committee. These bibliographies are on file in the offices of the Society and are to be loaned on request. The bibliographies are prepared by the staff of the Library of the United Engineering Society which is probably the largest Engineering Library in this country.

Mechanics F1-21 Fatigue of Metals. See *Properties of Engineering Materials F1-21.*

Petroleum, Asphalt and Wood Products F1-21. Recent articles on petroleum and allied substances prepared monthly by the Bureau of Mines. Address F. G. Cottrell, Director, Bureau of Mines, Washington, D. C.

Properties of Engineering Materials F1-21. Fatigue of Metals. The Joint Committee on the Investigation of the Fatigue of Materials under the direction of Prof. H. F. Moore has prepared a 16-page bibliography of books, monographs and articles dealing with the fatigue of metals and with related phenomena. Address Prof. H. F. Moore, University of Illinois, Urbana, Ill., or A.S.M.E., 29 West 39th St., New York.

CORRESPONDENCE

Contributions to the Correspondence Department of Mechanical Engineering are solicited. Contributions particularly welcomed are discussions of papers published in this Journal, brief articles of current interest to mechanical engineers, or suggestions from members of The American Society of Mechanical Engineers as to a better conduct of A.S.M.E. affairs.

Readers Requested to Send Suggestions

To the Editor:

In my lectures on the principles of management, students are required to do coördinate reading from books written by prominent engineers and business men. This part of the course is proving to be of great value, but in order to make it as effective as possible I would like the help and suggestions of engineers as to the best books for this purpose.

The problem is one of selecting the volumes which will inspire the student to strive for high ideals in engineering and in the management of industrial affairs. My present list is made up from my own experience, but I am sure that many helpful suggestions might be received from practicing engineers who employ engineering graduates. I would be very glad to have suggestions from the readers of Mechanical Engineering.

Bruce W. Benedict.

University of Illinois, Urbana, Ill.

DeLamater Ericsson Tablet Committee Report

To The Editor:

In your October issue you printed a statement regarding the DeLamater Ericsson Commemoration held during the last annual meeting of the A.S.M.E. and the movement since then to erect memorial bronze tablets on the sites of four buildings in this city with which the lives and work of Mr. DeLamater and Captain Ericsson were associated.

As it was largely through the courtesy and assistance of the A.S.M.E., of which Captain Ericsson was a member, that this meeting and movement took place, the Committee feel that it would be proper to report in the columns of its publication the status of the subscriptions which have been made to them so far.

For the Commemoration Meeting each of the following societies subscribed $50.00:

American Scandinavian Alliance of Greater New York
American Scandinavian Foundation
American Society of Mechanical Engineers
American Society of Refrigerating Engineers
American Society of Swedish Engineers
Associated Veterans of the DeLamater Iron Works
Engineers' Club of New York
John Ericsson Memorial Committee (by Mr. John Aspegren, Chairman)
New York Historical Society
Society of Naval Architects and Marine Engineers
Union League Club.

Total Subscriptions	$550.00
Total Expenses	375.00
Balance	$175.00

The A.S.M.E. also furnished the auditorium, lantern and ushers, and the American Scenic and Historic Preservation Society, through its secretary, Dr. E. H. Hall, gave valuable assistance in arranging for the meeting and is printing an account of it, with excerpts from the addresses, in its report to the state legislature. Reprints of this report will be furnished to the subscribers to the meeting and to the Tablet Fund, which latter to date comprises individual members of the following societies and individuals:

Amaranthus Lodge, Independent Order of Odd Fellows	$25.00
American Scandinavian Foundation	10.00
American Scenic and Historic Preservation Society	25.00
American Society of Mechanical Engineers	99.00
American Society of Refrigerating Engineers	30.00
American Society of Swedish Engineers	250.00
Associated Veterans of the DeLamater Iron Works	256.00
Bredablick Lodge, Free and Accepted Masons	250.00
Capt. John Ericsson Memorial Society of Swedish Engineers	130.00
General Society of Mechanics and Tradesmen	323.04
John Ericsson Memorial Committee	75.00
Past District Deputy Grand Masters' Association of Greater N. Y.	10.00
United Swedish Societies of N. Y.	250.00
DeLamater family	700.00
Thomas F. Rowland	500.00
Ogden Mills	250.00
Wm. H. Todd	100.00
Stevenson Taylor	50.00
Brought forward balance of Commemoration Fund	175.00
Total Subscriptions (to date)	$3508.04
Total Expenses (to date)	$ 105.00
Balance	$3303.04

It is hoped that subscriptions from American societies will exceed or at least equal those of the Swedish societies and that there will be besides many patriotic and public-spirited individuals who realize and appreciate the valuable services which Mr. DeLamater and Captain Ericsson rendered to this country and will help to raise

the amount of the fund to $5000, which is what is needed to make and erect the tablets which the Committee have in hand.

The Committee has in hand the development of a motion-picture scenario of the life of Captain Ericsson, which was full of highly dramatic occurrences. This will be of great educational benefit to the public in advance of the dedication of the John Ericsson Memorial in Washington, D. C., on the 60th anniversary of the battle of the *Merrimac* and the *Monitor*, March 9, 1922.

Names of individual subscriptions will be supplied later.

H. F. J. Porter, *Chairman,*
DeLamater Ericsson Tablet Committee.

25 W. 39th St., New York City,
December 1, 1920.

Eliminating Monotony from Work

To The Editor:

At the meeting of the Society held on November 5, a very important principle was emphasized by Mr. Gompers when he stated that the efficiency of human life must take precedence of the efficiency of human production, and it was of the highest significance that Mr. Dickson, presumably viewing the situation from the opposite end of the industrial scale, in effect endorsed the statement of Mr. Gompers.

This statement admits the principle that the man is greater than either the dollar or the machine, and its acceptance by such representative men as Mr. Gompers and Mr. Dickson amounts in a sense to an official indorsement on behalf of all parties interested in the adjustment of industrial relations.

It will doubtless be readily admitted as a theoretical proposition that the man is more than the dollar or the machine, but actually to design our machines and processes with a view, firstly, to their effect upon the operator, and secondly, to their productive efficiency, means a radical departure from our present methods of procedure; and yet it would appear that the time has come when we must at least make some serious effort in this direction if we are to avoid the rocks which lie ahead.

The situation presents to the engineer a problem the solution of which must call into play his highest qualities, both social and professional, but at the same time it opens to him a field of usefulness which far transcends the mere production of physical wealth, and places him in a position of leadership in the upward progress of humanity.

It is most desirable that in dealing with this matter we should conserve, as far as possible, all that is best in our present system, not applying revolutionary methods, but guiding development along sound evolutionary lines.

One of the most productively efficient, but at the same time most humanly destructive, factors in our present system is monotony of operation, and it seemed to be the consensus of opinion that the evils of this could not be overcome without destroying the method. The productive advantages of this method however, are so great, both to the community at large and to the producers, that every effort should be made to ameliorate the evils without too great a sacrifice of efficiency, and the writer is hopeful that much may be accomplished in this direction.

The question which presents itself is: Are the evils of a monotonous process entirely inherent in the monotony, or can they to some extent be eliminated? To be more specific, is the distress chiefly caused by the contemplation of a monotonously recurrent process, or by what we may term a monotonously received fatigue shock?

The validity of this question will be apparent if we consider such an operation as hand knitting. Those who are expert in this work carry it on in such an automatic manner that they can engage in conversation or other form of mental activity without detriment to the work, and yet it is such as these who find knitting to be a pleasurable occupation; but if we look into the matter closely we shall find that the work is generally carried out under the most comfortable conditions and with a minumum of fatigue.

There is an old superstition which is dying, it is true, but dying hard, that a workman earns his wages in exchange for his fatigue. Let us forget this superstition and admit that fatigue is an evil and the enemy of efficiency; would it not then be possible to redesign some of our more monotonous processes so that they may be carried out under the most comfortable conditions and with a minimum of fatigue shock?

The writer does not expect that all the evils of monotonous operations can be eradicated, but as it is obvious that most of them have been designed without due consideration of the above factors, he is very hopeful that a full investigation of the subject may lead to valuable results.

James O. G. Gibbons.

East Orange, N. J.

Specialized Training in College

[An article on The Training of Engineering Students in Industrial Management by Prof. W. B. Benedict of the University of Illinois, published in the September issue of Mechanical Engineering, p. 492, brought forth a letter of discussion by W. D. Ennis, New York, N. Y., which appeared in the November issue of Mechanical Engineering, p. 640. The following is a further discussion of this subject, presented in a letter to Mr. Ennis and here published by permission.—Editor.]

I have read your letter in the November number of Mechanical Engineering with much interest, because, having spent the major part of sixteen years in technical teaching, and eight in marine engineering, about four years at sea, and the remainder in designing and estimating, I feel that I have combined engineering and commercial experience in sufficient quantities to enable me to get a good idea of just how much of what a man gets in college is useful to him afterward. I might add that during all my teaching years I had from three to four months every summer as vacation, and that I devoted nearly all these periods to practical work in various engineering plants.

Now there is nothing at all brilliant about myself; I am today "rotten" at pure calculus; much of theoretical thermodynamics; the higher and more mathematical parts of alternating currents; and all the more abstruse parts of naval architecture. Consequently, I feel that it is quite fair, in such things, to judge others by myself. The net result of this judgment is that we cannot afford in the four years that is all most boys can spend in college, to specialize them too much. In other words, we cannot turn out managers, superintendents, production engineers, time- and motion-study experts, transportation men, automotive men, internal-combustion experts, etc. I took my own course in mechanical engineering under the stern but beloved administration of the late Dean Joseph F. Klein; and as an undergraduate I often criticized Lehigh because there were no shops there, and no "practical work" such as other colleges had. To be sure, we had our "shop visit" courses, with the free run of the Bethlehem Steel Co., the Bethlehem Foundry & Machine Co. and other local industries, besides the Lehigh Valley Shops and the Ingersoll-Sergeant Works at Easton, and occasional trips to Niagara Falls and other centers of industry or power development; but *we did no work with our hands*, with the exception of a little in the college laboratories. But we did have the principles, the mathematics and the mechanics of it all most thoroughly drilled into us, and I think we went out able to tackle, *at the bottom*, any branch whatever of mechanical engineering. I had grown up, myself, in the mining and manufacturing city of Wilkes-Barre, Pa., and had spent much of my spare time around the shops and mines; and when I entered college, I was quite "fingerwise," as Gilbreth says.

And when I left college, and through the kindness of the late James S. Doran was allowed to go away to sea on the old *Pennsylvania* of the Red Star Line, I found that even the small store of practical experience I had already acquired was of small use. Even jobs that seemed similar were done in a different way. I learned how to "take leads;" how to work up a set of indicator cards without a planimeter; that Whitworth nuts will run down on a Sellers stud, but Sellers nuts won't run down on a Whitworth stud; and that taking the "lost motion" out of a 24-in. crankpin was an entirely different job from taking it out of a 3-in. one. During the years I spent at sea I was transferred around from ship to ship as all engineers are, and served under several different chief engineers; and two of these men were masters of

their profession: Messrs. Wm. G. Coxe, who was my chief on the *Pennsylvania*, and John Hunter, who was my chief on the *St. Paul*. Mr. Hunter is now naval constructor for the Standard Shipbuilding Corporation on Shooter's Island, and Mr. Coxe is once more my chief, as he is now vice-president and general manager of the Pusey & Jones Company. They were the only "post-graduate professors" I ever had, and none could have been better. ....And after some years at sea I went into a marine drafting room and began to get another line of instruction and experience.

I found, for instance, that it was possible to get out all the principal dimensions of a triple-expansion engine in a few hours, and that my college bugaboo, thermodynamics, could be entirely dispensed with, barring a few figures and tables. And I remembered that Mr. Hunter had once told me at sea that all engineering consisted of "decimal fractions, common-sense and experience." Another time, when I was overhauling an especially mean set of metallic packing, Mr. Coxe had come along the grating and said, "All that trouble comes from too much 'white shirt' in the drafting room."...And through all this I wondered whether going to college had done me one bit of good....But I see now, and have seen for a good many years, that it had done me all the good in the world: for one thing, it taught me not to be afraid of anything that came up. Had I learned how to take leads or chip oil grooves and keyways in college, it would have been at the expense of some of those general principles that had been hammered into me.

Since I have been with my present employers my work has been principally marine estimating. We have here a pretty good system, and we are making it better right along. I could teach this system or method in a college, but I should want students who were at least seniors, and good ones at that; and I should want at least a year to do it, with lectures, recitations, practicum and quizzes. And when I had a boy as well taught as possible, do you think any shipyard would give him a *responsible* job at a good salary? Not in twenty years! He'd have to work up to it from the drafting room, the shops or the yard. So many boys seem to have a horror of the drafting room. They seem to think it means signing a life contract to hang over a board, just because they start in on one. It is one of the best doorways to better things in any engineering plant, and it is about the only place where they can make an immediate use of what they have learned in college. If they go into the shop, the youngest apprentice boy can "show them up," and their ignorance of shop practice is apt to make the so-called practical men about the plant think that, because they don't know much about the way things are done in the shop, they don't know anything. Nobody seems to think that an architect ought to be a skillful bricklayer, yet lots of shop men think that if a man can't run a milling machine or line up an engine, he can't do anything in the plant. Not that a good knowledge of shop practice is not a tremendous asset to any mechanical engineer: in fact, it is a *sine qua non* of really good design. And any chap with proper ambition can get all he needs by putting in his summer vacations at it while he is still in college. And after he goes to work, if he starts in the drafting room, he can learn a great deal by making friends with the various foremen, and submitting preliminary designs to them for their criticism. This is especially helpful, not only in fostering a spirit of coöperation, but in enabling a draftsman to design to suit his own plant's shop equipment; for often what is the best way to design for one shop is the wrong way to design for a shop with a different outfit of machine tools. I learned this by costly experience, and pass it along for what it is worth.

Probably you have been able to guess that my principal object in this letter, though not very precisely stated, is: Don't introduce *any* highly specialized course into a *college*. Leave them to trade and industrial schools and to post-graduate courses. How many boys entering college *know* what they want to do? Not one in fifty. So give them the great General Principles, and let them hew out a niche for themselves, where they will fit, after they get out. I once heard the late Eckley Coxe say, "If your four years in college have taught you nothing but that you are unfitted for the profession you set out to study, they have not been wasted."

Wilmington, Del. W. S. Ayars.

WORK OF THE A.S.M.E. BOILER CODE COMMITTEE

The Boiler Code Committee meets monthly for the purpose of considering communications relative to the Boiler Code. Any one desiring information as to the application of the Code is requested to communicate with the Secretary of the Committee, Mr. C. W. Obert, 29 West 39th St., New York, N. Y.

The procedure of the Committee in handling the cases is as follows: All inquiries must be in written form before they are accepted for consideration. Copies are sent by the Secretary of the Committee to all of the members of the Committee. The interpretation, in the form of a reply, is then prepared by the Committee and passed upon at a regular meeting of the Committee. This interpretation is later submitted to the Council of the Society for approval, after which it is issued to the inquirer and simultaneously published in Mechanical Engineering.

Below are given the interpretations of the Committee in Cases Nos. 318 to 321 inclusive, as formulated at the meeting of October 14, 1920, and approved by the Council. In accordance with the Committee's practice, the names of inquirers have been omitted.

Case No. 318

(In the hands of the Committee.)

Case No. 319

Inquiry: Is it allowable, under the requirements of Par. 308 of the Boiler Code, to connect to a boiler to be operated at a pressure exceeding 15 lb. and not to exceed 100 lb. for the return of condensation to a heating system, a 4-in. return connection, this same return connection being used as a blow-off, but the blow-off connection therefrom being reduced, however, to $2^1/_2$ in. pipe size or less?

Reply: It is the opinion of the Committee that such a connection for return of condensation will not be in accordance with the requirements of Par. 308 of the Code. It will be necessary to use an independent connection for the return.

Case No. 320

Inquiry: Will it meet the requirements of Par. 303 of the Boiler Code where a non-return angle valve is mounted directly on the steam outlet nozzle of a boiler, and to the outlet of this valve there is bolted a gate valve, forming the two stop valves required, to provide the ample free-blow drain between the two valves by a $1^1/_2$-in. pipe tap in the side of the non-return angle valve just above the seat, in order to avoid the necessary of placing a fitting between the two valves?

Reply: It is the opinion of the Committee that such a construction will fully meet the requirements of Par. 303.

Case No. 321

Inquiry: Is a boiler of the porcupine type where stub tubes are screwed in the furnace sheet subject to the requirements of Par. 250 of the Boiler Code, or is the screwed connection of such stub tubes permissible?

Reply: Par. 250 refers specifically to fire-tube boilers and is therefore not applicable to a boiler of the porcupine type in which the tubes are operated under conditions similar to those of the water-tube type of boiler. Par. 251 refers to tubes which are expanded into the tube sheets and does not apply to tubes with screwed ends. It is the opinion of the Committee that the pipes or tubes should meet the requirements recommended by the Committee in the reply for Case No. 296—that special redrawn pipe, not to exceed $1^1/_2$-in. standard pipe size made from lap-welded iron of puddled stock and tested to 1000 lb. hydraulic pressure, may be used for a working pressure not to exceed 200 lb. per sq. in., provided the wall thickness is at least 50 per cent greater than the wall thickness required by the Code for tubes of water-tube boilers. The minimum number of threads should conform with the values given in Table 8 of the Code. The closed ends of the stub tubes may be welded by the forging process.

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The Engineer's Work at Hog Island

Carl C. Thomas

The great shipyard at Hog Island, built by the American International Shipbuilding Corporation for the Emergency Fleet Corporation of the United States Shipping Board, has served successfully the purpose for which it was built and will soon be closed. Many of the members of this and of the other engineering societies were instrumental in carrying forward this undertaking, and the building of the plant and ships is one of the greatest examples of engineering and industrial coöperation. Not only were the executives and engineering forces drawn from many branches of the engineering profession, but the material for the ships and their equipment was supplied by more than 3500 different companies located in widely separated sections of the country. To the able and enthusiastic efforts of these organizations is due in large measure the marked success with which the program was carried out. The closest coördination was necessary to bring together materials and equipment in proper sequence to fit into a carefully planned construction program of such magnitude.

The Hog Island Yard is just completing the last of its contract for 122 steel vessels of the highest rating in Lloyd's and the American Bureau of Shipping Registries. Most of these ships have been in service for many months—and the *Quistconck*, the first to be completed, has steamed upward of eighty thousand miles. A recent examination showed here to be in first-class condition in every respect. Similar records have been made by many of the other Hog Island ships and all have given entirely satisfactory performance. The *Liberty Glo* was blown in two by a mine in the North Sea in December, 1918. Both ends floated ashore on a Dutch island some miles away, saving both crew and cargo, with the exception that two men who left the ship in a small boat died from exposure, and the cargo in the one ruptured hold was of course lost. The ship was put together again in Holland and has been in satisfactory service ever since under her original rating. At least six cases are on record in which Hog Island ships have rescued disabled vessels and towed them safely to harbor. The twelve 8000-ton troop-carrying vessels built in addition to one hundred and ten 7800-ton cargo ships, are to be used principally by the Army Transport Service, their interior arrangements having been radically changed from the original design to suit the revised army requirements. The last of the troopships are now about to go into service and the great yard, which was taken over by the United States Shipping Board according to the original arrangement with the American International Shipbuilding Corporation, is to be disposed of by the Shipping Board.

Hog Island is the largest shipyard in the world. The 50 ways occupy a waterfront over a mile in length, the wet basins and outfitting piers about three-quarters of a mile, and the storage yards at the two ends bring the total length to about two and a half miles. The width of the yard is about three-quarters of a mile. There are 84 miles of standard-gage track serving the storage yards, warehouses, ways and wet basins. Each of the seven outfitting piers is 1000 ft. long and accommodates four ships, so that 28 ships can be berthed at one time. During the war, in the period of greatest activity at the yard, fully 36,000 employees were constantly at work. The shipyards and engineering establishments of the country as a whole were in urgent need of all the labor that could be made available and it was an enormous task to maintain the great force of men required by such an undertaking as that at Hog Island. The work of building the yard was started in September 1917, and by the early part of February the 900 acres of swamp land had been so far drained, graded and built upon that the first keel could be laid at that time. Wherever buildings, tracks or ways were to be constructed the ground required that piles should be driven. An enormous amount of dredging was necessary along the river front and all of this work was done in spite of the unprecedented severity of the weather in the winter of 1917–1918. The building of adequate roads and providing of transportation facilities between Philadelphia and the shipyard, a distance of about nine miles, was in itself a great task; and in addition housing accommodations were provided for several thousand employees at the Island.

The designing of the ships and their equipment and the ordering of material proceeded contemporaneously with the designing and building of the shipyard, and material for the ships was rushed to the Island with the greatest possible speed. The work of storing the enormous quantities of material required for so large a number of ships and of arranging for delivery in the sequence necessary for systematic progress in construction, required the services of a large and well-organized storage department. Perhaps an even greater task devolved upon the purchasing department because of the fact that everything going into the ships was made and purchased and inspected in distant places. This required a very large force of inspectors and expeditors as well as an elaborate system for tracing the vast shipments of material.

In the old-line shipyards the material constituting the ships, from hull steel to and including equipment, is largely worked up and made at the yard. In the case of Hog Island everything had to be made away from the shipyard and delivered in a condition so true to the drawings that the parts would fit together satisfactorily. This involved much more detailed design work than would otherwise have been necessary and an unusual amount of care upon the part of the inspection force. This was especially true because the greater part of the material was made by firms who had never before done marine or shipbuilding work. For example, rudders were made at steel works in Kansas City, Minneapolis, Pittsburgh and Cleveland; anchor windlasses in Chattanooga; winches in Minneapolis and Ashtabula; capstans in Denver; and hull steel was worked up, sheared and punched to templet in some forty different fabricating shops in as many localities.

The close coöperation required by these conditions has undoubtedly had the effect of uniting the engineers of this country and bringing them into closer working contact. It has also given great cause for a feeling of encouragement as to the ability of our industries to rise to an emergency and serve the country with energy and enthusiasm in time of need. The difficult conditions

under which the work was done at Hog Island were doubtless duplicated in many of the great undertakings of the war and in many industries aside from shipbuilding.

It is greatly to be regretted that misinformation regarding this great project was spread throughout this and other countries. In common with other undertakings for which Government agencies were ultimately responsible, Hog Island suffered from malicious attacks from political groups. Expensive and time-consuming investigations were set on foot by these agencies which greatly delayed shipbuilding and which, far from discovering any of the dishonesty or incompetence charged, only served to show conclusively that the work was being done energetically and effectively; and in spite of great difficulties, attaining a speed of production and excellence of output which could not be brought about by any but an exceedingly high-grade and well-organized body of engineering executives.

Hog Island now stands in the eyes of the country as one of the striking examples of what American engineers can do. It is one of the very few instances in which a war venture has been so conceived, constructed and operated as to be able to continue producing a successful product in times of peace.

Elaborate investigations conducted after the yard was completed and in operation showed that it had cost far less than the sum which would have been necessary to reproduce it at the time of the investigations.

This country may well be proud of its great engineering firms which have carried through with fidelity enormous undertakings for the benefit and convenience of mankind; and of the fact that one of these firms organized and brought to successful issue the great undertaking at Hog Island, in response to the emergency call for ships. CARL C. THOMAS.

Measuring the Two-Hundred Millionth Part of an Inch

Our knowledge of engineering phenomena is limited by our ability to measure them. The difference between engineering knowledge and guess lies in the fact that the former is based upon data obtained from actual measurements, while the latter presupposes and assumes things which may or may not be so.

With this in mind it is easy to see why any refinement in our methods of measurement is likely to bring about a material increase in our knowledge of engineering phenomena. This has been well illustrated in the great realm opened up by the ultra-microscope. In the field of measurement of lengths the micrometer has been of incalculable value for many years. Of late, however, new methods of measurement based on the employment of light waves have extended the precision achieved by micrometers to within the region of one-millionth of an inch, and now comes the ultra-micrometer of Professor Whiddington of Leeds University, by means of which measurements to within the scarcely credible limit of one two-hundred millionth of an inch can be carried out with apparently great precision. This novel method is based on certain electrical phenomena which may be in general described as follows:

If a current be sent through a circuit containing an inductance coil and a condenser, the circuit will have what is known as a natural frequency, that is, a certain frequency of alternations depending on the respective values of the inductance and capacity involved.

If another circuit with an inductance and capacity be magnetically linked with the first circuit and a telephone be inserted in the first circuit, a sound will be heard in this telephone whenever the frequencies in the two circuits do not exactly coincide. The volume of the sound and hence its audibility depend, however, on the current flowing and the difference between the frequencies in the two circuits, and it is obvious that in order to make the device very sensitive it is necessary to make the telephone sensitive to extremely small variations, which can be done only by having both the current and the difference in frequencies very small.

On the other hand, as stated, the frequency in the primary circuit depends on the values of the inductance and the capacity. With the inductance constant the frequency of oscillations becomes a function of the capacity only, and the capacity may be varied by varying the distance between the condenser plates, which is the distance that has to be measured, or is proportional to the distance measured.

Here again it is obvious that if the distance between the condenser plates changes by a magnitude of the order of a small fraction of a millionth part of an inch, the circuit must be extremely sensitive to record it. An ordinary oscillating circuit does not have this great sensitiveness, but by using the so-called "thermionic valve" developed primarily for wireless telephone and telegraph work the current in the primary circuit may be magnified many times before it is sent into the telephone without, however, materially disturbing either the frequency or the shape of the wave. In a thermionic valve the initial current, which may be and usually is extremely minute, establishes a flow of ions between two elements enclosed in a vacuum. This flow varies in frequency, direction and intensity exactly as does the initial current. There is also a secondary circuit established which is linked with the primary circuit in such a manner that one of its terminals is constituted by one of the elements of the valve between which the ionic flow takes place, while the other is located between the two elements. It is now obvious that when there is no current in the primary valve circuit, there is no flow of ions between its two terminals. Hence there is a vacuum between the terminals of the secondary circuit and no current can flow therein. As soon, however, as a current is established in the primary circuit, ions are projected from one of its terminals to the other over the terminal of the secondary circuit located between them. As a result a sort of bridge is established between the terminals of the secondary circuit, permitting the current in that circuit to flow. Every interruption in the primary circuit is accompanied by a corresponding interruption in the secondary circuit, and the strength of the secondary current varies as the resistance in the gap between its terminals in the valve, which, in its turn, varies as the number of ions in that gap, or as the strength of the primary current.

Now a variation of one two-hundredth of one-millionth part of an inch between the plates of the condenser would be far below the range of sensitiveness of an ordinary telephone, but it is sufficient to affect the sensitiveness of the thermionic valve and to change the flow of ions between its terminals, which, in turn, produces changes in the much larger current taken from an independent source and thus gives a sufficient current to affect the diaphragm of the telephone.

If the Whiddington ultra-micrometer can be developed to the practical stage so as to make its use possible in engineering laboratories (sufficient information is not yet available to show whether this has been done or not), its applications may prove to be both extensive and important. It has already been found that it permits measuring the deflection of a solid wooden table produced by the weight of a coin placed on its edge. There is certainly need of an apparatus capable of measuring the minute deflections produced by the application of small loads and stresses to members of large cross-section. For example, it would be of interest to see how large bridges are affected by small loads. Many years ago it was stated that it would be possible to wreck the Brooklyn Bridge by means of a violin so played that the vibrations set up would always be in unison with the oscillations of the bridge. Whether this can be done or not is not very important; but whether such structures undergo minute oscillations or not may prove to be a matter of considerable value.

Another problem that might be investigated by means of the new apparatus is the law of deflection of springs under small loads, a law of which we are entirely ignorant. The question of expansion of metals under very small changes of temperature is also one that might be considerably cleared up by our ability to carry out measurements in the region of fractions of a millionth part of an inch.

The foregoing are only a few of the problems in whose solution the ultra-micrometer might be of service. And to repeat again what was said in the opening paragraph, our knowledge of engineering phenomena is limited by our ability to measure them.

Government Reorganization and a National Department of Public Works

At the last meeting of Engineering Council held in Chicago, M. O. Leighton, Washington representative of the Council, presented a report dealing with the activities of the National Department of Public Works Association.[1] With Congress now in session, interest in a National Department of Public Works has naturally revived, and it is therefore timely to make a rather complete report on the progress of the movement. The following has accordingly been abstracted from Mr. Leighton's report:

Two outstanding facts which were not anticipated when the public works movement took shape in April 1919, are first, that the engineers of the country in good faith started something which they do not now seem inclined to finish, and second, that the scope of the movement and its ramifications extend beyond all limits written or spoken of at the time.

The Movement for Government Reorganization

The fundamental arguments for a Department of Public Works apply with equal force to the entire Government organization. There has grown in a short space of time a country-wide movement for Government reorganization. The National Education Association, the Women Voters' League and the Federation of Women's Clubs, are supporting a proposed Department of Education. The American Public Health Association and other organizations in the realm of sanitation and preventative medicine are supporting a Department of Health. Certain welfare organizations are advocating a Department of Public Welfare; there is also a movement for a Department of Aeronautics; and an old movement for a Department of Mines still exists. The National Budget Committee, having practically completed its labors in behalf of a budget system of Federal Finance, is actively turning its attention to the entire field of Federal reorganization. The National Budget Committee, the Public Works Department Association, and the National Education Association are participating in the activities of what is known as the National Committee for Governmental Economy, the purpose of which is to make and report upon a complete study for governmental reorganization. The report is practically completed.

In all of these organizations, with possibly one exception, the creation of a Department of Public Works is an accepted doctrine. Opposition exists in some of the organizations to the purposes of some others, but all unite in favoring a public works program, and the most favorable feature of this is the general agreement that the Department of Public Works should be created not through the creation of an additional Cabinet office but by a readjustment of the agencies already existing. It is the other new departments, therefore, that will have to carry the heavy legislative burden of overcoming the opposition to enlargement of the Cabinet.

The Amalgamation of Reorganization Efforts

Early in October there was a meeting in New York City, attended by Messrs. John T. Pratt, head of the National Budget Committee; Herbert Hoover; Henry L. Stimson, former Secretary of War; Paul Warburg; Major C. T. Chenery, and the writer, at which matters of Government reorganization were discussed, and particularly the need for and the possibility of amalgamating all reorganization efforts under a commonly accepted and supported program. It was brought out that if the many organizations conduct campaigns separately, each for its own particular project, the confusion created in Congress will probably result in no legislation. It was therefore decided to call a meeting of delegates from the several organizations advocating reform in the Government departments, to organize a Federal Reorganization Council, which would be the common body through which an accepted program would be carried forward.

The aforesaid meeting of such delegates was held in New York on October 14, at which time the nearly completed report of the National Committee on Governmental Economy was presented. That program provided for a general rearrangement of Government activities along functional lines, including the creation of a Department of Public Works by a reorganization of the present Interior Department, and an additional department to be called the Department of Education and Health, into which would be drawn such welfare activities as war risk insurance, vocation and rehabilitation, pensions, etc. The meeting for final organization will take place about November 15. The prospective field of such a council is not limited to the mere reorganization of Federal activities. It should become the authoritative unofficial body to engage in the work which will eventually lead to a distinct separation of the political features of our Government system from the conduct of departmental business.

The obvious result of all this is that a Department of Public Works, if created, will not be an achievement of engineers and architects solely, but of men and women of many professions and avocations. Such credit as will come to the engineers will be merely that of starting a good thing, unless the members of the profession revive their interest and resume a leading part in the campaign. If such a revival does not take place the cream of achievement will be skimmed by the members of other professions.

To summarize as to the prospects for a Department of Public Works. It is the writer's belief that the principle is thoroughly settled in the minds of the public and of a majority of the members of Congress. The important question remaining is the kind of a department that we shall have. This involves a discussion of the matter of engineering control of Government operations. Shall it be civil or military?

Civil or Military Control of Government Operations

It is easy enough for the thousands of engineers of the United States to assert that engineering work of the Government shall be under civilian control, but it is quite another thing to establish that control. The engineers of the country must decide speedily whether it be their desire to have military engineers in control of the public works of the nation, for if they do not bestir themselves and take a sustained and active interest in this matter they will suddenly find that the die has been cast. When Government reorganization takes place the provisions made for engineering control will crystallize and will not become mobile again for at least a generation. It all comes down to a question of what the civilian engineers want and what they will work for. They are strong enough numerically and powerful enough in influence to guide the decision if they choose to do so, but they must not entertain the notion that their adversary is asleep.

[1] The National Public Works Department Association is a league composed of individuals, associations and of national, state and local societies, having an aggregate membership of over 100,000 business men, engineers, architects, constructors, manufacturers, chemists, geologists and economists. Its purpose is to organize under one department the many and varied public-works functions of the Federal Government. M. O. Leighton is chairman of the Association, and C. T. Chenery, secretary. The Association's headquarters are in the McLachlen Bldg., 10th and G St., Washington, D. C.

Federal Power Commission

Perhaps the most important item to engineers in the 1921 estimates of Government expenditures was a relatively small one calling for a total appropriation of $482,065, for the requirements of the Federal Power Commission. Of this $100,000, it is estimated, is required to reimburse executive departments for investigations requested by the Commission; $137,000 for general expense for the authorized work of the Commission and $240,000 for salaries. All of these estimates appear to be conservative, in fact, as small amounts as will permit of effective operation of the Commission under the requirements of the law.

Before these estimates can be acted on for appropriation by Congress, however, it is necessary under the law to so amend the existing power act as to permit the Commission to spend the money so appropriated. If the law is not amended giving the Commission this additional power any appropriation bill carrying the item above referred to is subject to a point of order because regular appropriation bills cannot carry new legislation. It was evidently the intent of the original Federal power bill to give the Commission authority to hire and pay its personnel and to expend funds which were appropriated for it, but under a ruling of the controller of the Treasury these funds did not become available.

Since this whole appropriation will affect practically every phase of the engineering field, it is probable that engineers and engineering organizations as such should use their efforts to obtain, first, adequate legislation that will enable the Commission to properly expend this money, and second, an appropriation that will permit of proper execution of the law. The need of this legislation and its proper administration is best shown by the fact that 115 applications for permits or licenses for power development have been filed with the Commission in less than six months with an aggregate horsepower of over eight million.

A.S.M.E. Student Prize Award

The A.S.M.E. Student Prize for 1920, it was announced at the Business Meeting of the Society held during the Annual Meeting, has been awarded to Howard G. Allen, a graduate of Cornell University, for his paper on Wire Stitching Through Paper. This prize, consisting of an engraved certificate signed by the President and Secretary of the Society, and twenty-five dollars, is given to the member of a Student Branch who submits the best paper adjudged from the standpoints of applicability (practical or theoretical), value as a contribution to mechanical engineering literature, completeness, originality of matter and conciseness. This prize is provided for by a fund of $1000 established through the generosity of a member of the Society as an incentive to the young engineer to undertake original work and is in line with the practice of many other societies. A similar fund provides an award for the best paper submitted by a Junior Member; there were, however, no contestants for the latter award this year.

Arthur M. Waitt

Arthur M. Waitt, well-known consulting engineer of New York City, died on November 10, 1920. Mr. Waitt was born in October, 1858, in Boston, Mass. He was educated in the Boston schools and attended the Massachusetts Institute of Technology from which he received his S.B. degree in 1879.

Upon graduation he became connected with the C. B. & Q. Railroad, leaving that road several years later to become general foreman of the car shops for the Eastern Railroad Company. From 1885 to 1888 he was general foreman of the car department for the same company. In 1888 he became connected with the Boston & Maine Railroad as assistant master car builder and the following year took a position in the same capacity with the L.S. & M.S. Railroad. Three years later he became general master car builder for that company and was with them until 1899 when he became superintendent of motive power and rolling stock of the New York Central Railroad. He held this position until 1903 when he resigned to open consulting offices in New York City in which field of work he was engaged until the time of his death.

During the War, however, Mr. Waitt, who held the commission of Major, gave up his practice temporarily to organize one of the largest purchasing branches of the Ordnance Department in New York and Hartford. His death was due to overwork in this undertaking into which he entered so whole-heartedly.

During his connection with the New York Central he was made a member of the Electric Traction Commission which planned the electrification of the road from New York to Harmon. He also assisted in designing one of the best locomotives in use at that time, among them the engines of the series 1400 and 2900. He was associated after his retirement from the New York Central with Colonel William J. Wilgus in the appraising of the rolling stock of the Lehigh Valley Railroad. He was an enthusiastic supporter of the automatic train control and a director of the Sprague Safety Control & Signal Corporation.

Arthur M. Waitt

In 1893 Mr. Waitt was elected president of the Central Railroad Club of Buffalo and in 1895 president of the Western Railroad Club of Chicago. As one of the officers of the Lake Shore & Michigan Southern Railroad, he was a participant in the famous high-speed run of October 24, 1895, from Chicago to Buffalo; a run which, it is believed, has never been equalled. The test started at 3:29 a.m. in Chicago and ended at 11:30 a.m. in Buffalo, a total distance of 510.1 miles, done in eight hours, one minute and seven seconds.

In 1901 Mr. Waitt was elected president of the American Railway Master Mechanics' Association. In 1916 he became a member of the Connecticut Assembly and it was he who wrote the automobile laws now in force in that state.

Mr. Waitt was also a member of the Connecticut Chamber of Commerce, the New York Railway Club, the St. Louis Railway Club and the Engineer's Club of New York. He was a thirty-second degree Mason.

He became a member of The American Society of Mechanical Engineers in 1893 and held the office of vice-president from 1900 to 1902.

Edward W. Thomas

Edward W. Thomas, former president of the National Association of Cotton Manufacturers and for the last eleven years agent of the Boott Mills, Lowell, Mass., died of heart disease at his residence in that city on November 15, 1920. Mr. Thomas was generally regarded as one of the ablest cotton manufacturers in the country, having held responsible positions with mills both in the North and in the South. His eminent fairness in all matters of mill routine which came to him for discussion had won the confidence of the employees and this quality, combined with an unfailing courtesy even to the most humble operative, was a potent factor in the successful development of the large plant which he directed for the past eleven years.

Edward W. Thomas

He was born on February 22, 1858, in Lowell, Mass. He spent all of his business life in cotton manufacturing, starting as a draftsman with the old Lowell Machine Shop and leaving that concern to enter the employ of the American Thread Company at their plant in Willamantic, Conn. In 1882 he became superintendent of the Tremont & Suffolk Mills, Lowell, and four years later became agent for the corporation.

During this period he was particularly active in the affairs of the National Association of Cotton Manufacturers, serving as vice-president from 1892 to 1894 and as president in 1894 and 1895.

About 1900 Mr. Thomas went south to become general manager of the Cooleemee (N. C.) Cotton Mills, and in 1904 he assumed the more responsible position of general manager of the Olympia and Granby Cotton Mills, Columbia, S. C. Three years later he became general manager of all the plants of the Consolidated Cotton Duck Company, Baltimore, Md. In 1909 Mr. Thomas returned to Lowell as agent for the Boott Mills, which position he held at the time of his death.

Mr. Thomas was a member of both the National and American Associations of Cotton Manufacturers, the Boston Textile Club, the Yorick Club of Lowell and the Lowell Historical Society, of which latter he was vice-president. He had long been prominent in masonry and was a Knight Templar and a thirty-second degree mason.

He became a member of The American Society of Mechanical Engineers in 1880, attending the organization meeting at Stevens Institute of Technology on April 7, 1880. He served as secretary of the sub-committee on Textiles from 1912 to 1914.

SIDE CUTTING OF THREAD-MILLING HOBS

(Continued from page 11)

fore, if the correction is taken as the tangent of the profile at the pitch line of the thread, the angle C′ will remain unchanged. The formulæ for determining this angle are as follows:

Let C = $^1/_2$ included angle of thread
C' = $^1/_2$ included angle of corrected hob
H = helix angle of thread at pitch line

Then

$$\tan H = \frac{1}{\pi N \times \text{pitch diam. of thread}}$$

and

$$\tan^2 C' = \tan^2 C + \tan^2 H$$

It is evident from the above that if the form of the cutting edge of a hob of a certain diameter be corrected to cut a thread of a certain diameter and pitch, a variation in the diameter of the hob of, say, 25 per cent will have but little effect on the form of the thread produced on the work.

In order to determine the effect of varying the diameter of the work, the following tabulation was made for a hob 2.000 in. in diameter with 5 Acme threads per inch:

Work diam. =	1.000 in.	2.000 in.	4.000 in.
x_2 =	0.003475	0.001161	0.000350
y_2 =	0.012344	0.004103	0.001512
$2C'$ =	30° 0′ 16″	29° 14′ 8″	29° 3′ 6″
$F - 2x_2$ =	0.0619	0.0666	0.0682
K =	0.000054	0.000012	0.000003

The above tabulation shows that the amount of side-cutting at the bottom of the thread (x_2) decreases as the diameter of the work increases. The height of the fillet at the bottom of the thread (y_2) decreases as the diameter of the work increases. In this case it decreases about four times as much as x_2. The included angle of the corrected hob decreases quite rapidly as the diameter of the work increases. The width of the point of the corrected hob increases about 0.006 in. as the diameter of the work is increased from 1 in. to 4 in. The dimension K in Fig. 5-B decreases as the diameter of the work increases. In this case the amount of error introduced by a straight-line correction in the hob is in the fifth and sixth decimal place and is negligible. It is evident, therefore, that a hob which is corrected for a certain diameter of work cannot be used on work which varies very much in diameter if accurate results are desired. The smaller the diameter of the work, the more this condition is accentuated. This is due in large measure to the rapid increase of the helix angle on smaller diameters. On work of large diameters, where the helix angle employed is very small, little or no correction is required on the hob.

RAILWAY TERMINALS AND TERMINAL YARDS

(Continued from page 21)

There is but one railway whose freight tracks reach Manhattan Island. All the other lines maintain the connection by lighters. One hundred years ago it was the Hudson River that furnished an outlet for the Erie Canal and carried New York to the first place among American cities, thus establishing its ever-increasing commercial supremacy. On the advent of railways they, one by one, except the Hudson River Railroad, located their terminals on the Jersey shore and lightered their traffic across the water. As their business developed they increased their facilities, and as the city grew they created new points of delivery, but always maintaining their separate and individual identities. The consequence is that every railway coming from the west maintains on the Jersey shore great yards occupying valuable space whence freights are transferred by floats to various points not only on the edge of Manhattan Island, which was New York when railway traffic originated, but to the greater parts of what is now New York, namely, Brooklyn, Long Island and the Bronx.

Is this necessary? If it is not necessary, is it the best and most economical arrangement? Should not the terminal facilities of the several roads be pooled, thus concentrating operation on the part of the railways? Instead of maintaining special delivery stations in New York, can there not be a combining there, with perhaps a further segregation into places for delivery according to commodities? If the principle of "store door" delivery be adopted there seems to be no necessity for water-front terminals in New York and water-front yards in Jersey. New yards with switching connections at both ends can be constructed with modern freight houses and unloading tracks equipped with labor-saving freight-handling machinery. These could be located in any convenient place, even on the wide expanse of the Jersey meadows. To them motor trucks with trailers carrying not part but full loads would transport merchandise between cars and points of origin or destination in any part of the Metropolitan District. In such a system would there not be economy in handling, time saved in trans-terminal shipments and a relief to street congestion through diminished number of trucks? The first two are for the immediate benefit of the railways and shippers, but the last is for the benefit solely of the city.

There is a fourth advantage in which the nation as a whole and the Metropolitan District would share jointly. Already New York's harbor terminal facilities are overtaxed and there is danger of surplus foreign traffic seeking against natural laws other and consequently less well-situated ports. The freeing of such a large area of water-front property now held for local freight purposes only would render available a site for the finest kind of ocean-steamship terminals. This property is most advantageously located for such purposes. It would have complete rail connection with all lines and could be physically improved with piers having ample storage facilities and cargo-handling machinery. The opportunity would be presented whereby the port of New York could be almost indefinitely extended and with advantages, vastly superior to those now existing or obtainable elsewhere.

The writer is aware that none of these questions are new. They have all been asked before, but the present moment is a fitting one to ask them all again when our transportation lines are entering upon new principles of operating economy, and when all men feel the need of general readjustment of business methods to meet the new world conditions.

A Correction

We are advised that the superheaters installed at the new Ford plant, a description of which was published in Mechanical Engineering for November, were designed, manufactured and installed by the Locomotive Superheater Company, of New York. Credit was inadvertently omitted from the article.

Index to Volume 42 of Mechanical Engineering

An index to Volume 42 of Mechanical Engineering is now in the course of preparation, which, it is expected, will be issued early in February. A copy of this index will be sent to each member of the Society or subscriber who sends in a written request therefor. In order that no more copies than are necessary to supply the demand may be printed, requests for copies should be received at headquarters not later than February 1.

1921 Year Book

On the recommendation of the Publication and Papers Committee and the Finance Committee, the Council has agreed to defer the publication of the A.S.M.E. 1921 Year Book until about October 1.

The 1920 Year Book was corrected on March 1, but on account of printing difficulties did not reach the membership until about July 1. In deferring the publication of the new book until October the interval between the two volumes will be only fifteen months.

The list of Council officers and Committees published in the front part of the volume will probably be issued about February 10. This will be printed in the usual page size and slipped into the 1920 book for the time being.

Engineering and Industrial Standardization

Standard Ton of Refrigeration Defined

A special committee of The American Society of Mechanical Engineers consisting of Messrs. Fred Matthews, Chairman, Henry Torrance, Jr., Secretary, Charles W. Berry, Peter Neff, John E. Starr, and Gardner T. Voorhees, the membership of which was endorsed by the American Society of Refrigerating Engineers, was recently appointed to fix a "Standard Tonnage Basis for Refrigeration." Its findings reported to The American Society of Mechanical Engineers at its Annual Meeting held on December 7-10 were as follows:

(1) A standard ton of refrigeration is 288,000 B.t.u.

(2) The standard commercial ton of refrigeration is at the rate of 200 B.t.u. per min.

(3) The standard rating of a refrigerating machine[1] using liquefiable vapor is the number of standard commercial tons of refrigeration it performs under adopted refrigerant pressures.[2]

[1] A refrigerating machine is the compressor cylinder of the compression refrigerating system, or the absorber, liquor pump and generator of the absorption refrigerating system.

[2] These pressures are measured outside and within 10 ft. of the refrigerating machine, distances which are measured along the inlet and outlet pipes, respectively; (*a*) the inlet pressure being that which corresponds to a saturation temperature of 5 deg. fahr. (—15 deg. cent.) and (*b*) the outlet pressure being that which corresponds to a saturation temperature of 86 deg. fahr. (30 deg. cent.).

The Committee and The American Society of Mechanical Engineers will welcome a full and free discussion of these three propositions. Communications should be addressed before February 15 to the Standards Department of The American Society of Mechanical Engineers, at 29 West 39th Street, New York City. As we go to press, we are informed that this report has been approved by the American Society of Refrigerating Engineers.

What is "Wrought Pipe?"

When the pipe maker takes a length of steel skelp and a length of wrought-iron skelp and forms them into pipe, he performs exactly the same operation on both materials, that is, he bends them into tubular shape and welds the edges. Quite correctly, therefore, the American Society for Testing Materials in their specifications use the word "welded" in conjunction with both wrought-iron and steel pipe made by the processes of welding.

Probably some thirty years ago, after the introduction of welded steel pipe, the term "wrought pipe" or "wrought steel pipe" was coined by steel-pipe manufacturers; this term gradually came into use by dealers and jobbers; thus steel pipe would be billed and listed as "wrought pipe." The average consumer of pipe, not acquainted with this trade name frequently labors under the impression that it means wrought-*iron* pipe. In fact, the names being so much alike, have led to the term "wrought-iron pipe" by the jobbers and contractors being interpreted as meaning steel pipe, defying architects' and engineers' specifications and resulting in endless confusion.

The manufacturers of wrought-iron pipe, actively aided by the American Institute of Architects, have therefore taken up with the supply associations the matter of clarifying these so-called trade names, suggesting instead names that would ultimately result in eliminating all confusion of puddled wrought iron with pipe made from soft steel. It was argued that trade names which conceal the truth are misleading, even to buyers who are supposed to be well informed, and that the substitution of the word "welded" for "wrought" would create a common term for both kinds of pipe impossible of misinterpretation. As a result the National Pipe and Supplies Association at their meeting held in New York on November 11, voted that the terms employed by the American Society for Testing Materials in differentiating between iron and steel pipe, viz.: (*a*) Welded Wrought-Iron Pipe, and (*b*) Welded Steel Pipe, should be accepted and adhered to by the distributors of both iron and steel pipe, this being in the interest of the manufacturers of the pipe, those who distribute it, and those who use it, each of these parties being entitled to know clearly and without doubt the make and quality of the pipe involved in the transaction.

This step should result in the term "welded pipe" being applied when *both* wrought iron and steel pipe are referred to, and that the latter two terms alone, namely, "wrought-iron pipe" on the one hand and "steel pipe" on the other hand, be used and interpreted respectively to mean exactly what these terms imply. Thus "wrought-iron pipe" will mean only pipe which is made from genuine puddled wrought iron, and "steel pipe" will be used exclusively to designate pipe made of soft bessemer or open-hearth steel.

American Engineering Standards Committee Recently Enlarged

The American Engineering Standards Committee has recently been enlarged by the representatives of four additional member-bodies. These bodies and names of their representatives are as follows:

(1) U. S. Department of Agriculture; T. H. MacDonald, Chief, Bureau of Public Roads

(2) U. S. Department of Interior; O. P. Hood, Chief Mechanical Engineer, Bureau of Mines

(3) Gas Group (consisting of American Gas Association; Compressed Gas Manufacturers' Association; International Acetylene Association); A. Cressy Morrison, Vice-President, Compressed Gas Manufacturers' Assn.

(4) American Electric Railway Association (official representative not yet designated).

There are now forty-seven members on the Committee, representing seventeen member-bodies, and twenty-four organizations as three of the member-bodies are groups of organizations.

The Committee recently held its annual meeting in New York and A. A. Stevenson, a representative of the American Society for Testing Materials, was reëlected chairman for 1921, and George C. Stone, a representative of the American Institute of Mining and Metallurgical Engineers, was reëlected Vice-Chairman. The following were also elected to represent the respective member-bodies on the Executive Committee:

Comfort A. Adams, American Institute of Electrical Engineers
Martin Schrieber, American Society of Civil Engineers
Fred E. Rogers, American Society of Mechanical Engineers
A. H. Moore, Electrical Manufacturers Council
Dana Pierce, Fire Protection Group
A. Cressy Morrison, Gas Group
N. A. Carle, National Electric Light Association
Albert W. Whitney, National Safety Council
Coker F. Clarkson, Society of Automotive Engineers
Thos. H. MacDonald, U. S. Department of Agriculture
E. B. Rosa, U. S. Department of Commerce
O. P. Hood, U. S. Department of Interior
Francis J. Cleary, U. S. Navy Department
J. H. Rice, U. S. War Department.

National Standardizing Body Organized in Austria

There has recently been formed in Austria a national engineering standardizing body. It is called the "Normenausschuss der Oesterreichischen Industrie" and is organized under the auspices of the "Hauptverband der Industrie Deutschoesterreichs." The Secretary is Dr. Jaro Tomaides.

This is the tenth national standardizing body to be formed, the others being in Belgium, Canada, France, Germany, Great Britain, Holland, Sweden, Switzerland, and the United States. Mechanical Engineering for September contained a brief description of the form of these organizations, all of which, with the exception of the British Engineering Standards Association, whose work dates from 1901, have been formed since the beginning of the European war.

The Recataloging of the Engineering Societies Library, New York

Work Begun in September, 1919—The Steps Involved and Difficulties Encountered—Results to be Gained and their Great Value to Engineers

By HARRISON W. CRAVER, DIRECTOR

THE Engineering Societies Library of today has for its ancestors four separate libraries which began at different periods, were developed in different ways and with varying ideals, and had not attained the same degrees of development when they were combined. The methods of classifying the books and of cataloging them in use in the separate libraries were so dissimilar that a revision of all this work was essential if members were to use the collection conveniently, and with any assurance that all the material available had been found.

The Library Board therefore decided, early in 1919, to undertake the recataloging of all the material. As no uniform scheme for classifying the books was in use, much reclassification is also involved. A special corps of workers was assembled for the task and since the fall of 1919 the energies of the staff have been chiefly concentrated upon it.

As it is believed that the methods adopted will not only fix the practice of the Library for years to come, but may also become the standard for other engineering collections, every effort has been made to adopt methods that will both meet present needs and also provide for future developments, so far as these can be predicted. This has involved the sacrifice of speed, but as the work is intended to be permanent, basic soundness has been considered the prime quality.

At present, approximately one-fourth of the work is done. The recataloged material includes all the publications of the past four years, and those classes of the older material most in use; among others, the periodicals, and the geological material for many states. Work on the remaining material is proceeding class by class, the most important classes being treated first.

The following extracts from a report submitted in October by Miss Margaret Mann, chief cataloger, give detailed information on certain phases of the problem. They will, it is hoped, be of interest to many engineers and members of the A.S.M.E. as showing what has already been done, the difficulties to be overcome and the results anticipated when the work is finished.

During the year from September, 1919, to October, 1920, 23,204 books have been completely cataloged, and 31,679 volumes have been handled in order to catalog these 23,204. The 23,204 volumes represent 5000 titles. From these 5000 titles we have made available 10,301 subjects. To catalog 23,204 volumes, or 5000 titles, completely by author and subject, we have had to handle 31,679 volumes, which has necessitated the preparation and filing of 53,793 cards and the typing and filing of 840 sheets into loose-leaf binders. This has been accomplished with a staff averaging ten.

Steps Involved in Recataloging

The recataloging involves the following processes:

1 *Classification of the Book.* This means fitting the book into an accepted system of classification and getting it into its proper relation with all other books in the collection. Requires *expert* assistants.

2 *Compiling an Alphabetical Key or Index to This Classification.* This key now numbers 10,000 entries.

3 *Developing the Classification.* Making additions for the new subjects which are constantly coming up in engineering.

4 *Cataloging.* So recording the book that it may be reached from any angle—author, subject or title. This often involves the preparation of ten or more cards for each title and necessitates careful bibliographical research.

5 *Shelf Record of Books.* A record of every book as it stands on the shelves by number. Necessary (1) as an inventory of the library collection and (2) to avoid duplicating the individual symbol by which each book is known in a library.

6 *Record of Magazines and Transactions of Societies.* A loose-leaf record of every set in the library, showing not only the volumes on our shelves but also what volumes, indexes, etc., are needed to make our files complete. The compilation of this list has been slow work because of the condition of the sets. Many volumes are unbound, making it necessary to do very careful collating, while other volumes are incorrectly bound and incorrectly marked, making reference to them impossible. Many duplicates have necessarily been handled in the process of combining the several societies' collections.

7 *"Want" List of Magazines and Transactions of Societies.* This list shows at a glance what volumes are needed to complete our files. It can be sent to dealers for bids on missing numbers and volumes, and can also be printed in our own society journals and used as a means of calling the attention of members to our wants. Many incomplete sets might be filled through this channel. The Library has never before been able to take advantage of offers of duplicate volumes from other libraries or from individuals because no such list of our needs was available.

8 *Binding.* Every volume sent to the bindery must be collated, tied up and a record made of the author, title and volume number, together with directions to the binder as to style and kind of binding. When the volumes are returned, these records must be checked.

9 *Preparation of Books for the Shelves.* Every book must bear a symbol which shall distinguish it from every other book in the collection, so that it may take its proper place on the shelves. This symbol is placed on the back of every book, and the societies' book plate is pasted into each volume before it is sent to the shelves.

10 *Shelving of the Books.*

11 *Filing of the New Catalog Cards and the Removal of the Old Records from the Old Catalogs.* The removal of old cards is an important but arduous task. To leave these cards in the catalog means that readers or assistants will look for books under the old numbers and so be misled. This is one of the difficulties of keeping both the old and the new going at one, and the same time.

Difficulties Encountered

The work has been necessarily slow this year because of the following difficulties:

1 *Difficulty of Keeping All Material Available While the Recataloging is in Process.* So long as the Library is kept open, every book must be available when needed. This often retards the work of the cataloger by requiring him to keep the books he is cataloging accessible to readers, when different methods would be more efficient for the cataloging process.

2 *The Necessity of Making Old Records Guide One to the New Records.* Constant references must be made to show what classes of books are in process, what have been recataloged, where they are located and to what extent completed.

3 *Inadequate Equipment,* especially shelving, book trucks, filing cabinets, etc.

4 *Distance of Records* from the catalog workman. The main catalog, which must be constantly consulted, is on the 13th floor, while the work room is on the 14th.

5 *Scattering of Material on Three Floors.* We have found it necessary in tracing a periodical set to inspect twenty different records or shelves before we were sure all material and information had been collected which bore on that special title.

6 *Necessity of Collating Unbound Material.* The collection is made much more difficult to handle because so little binding has been done. The tying and untying of hundreds of unbound volumes adds materially to the time required for recording these.

7 *Inability to Get Binding Done During the Current Year.* It has been difficult to get adequate work or service and the cost has been increased.

8 *Difficulty of Getting Good Trained Assistants.* The "after war" advance in library salaries has made it impossible for us to get the kind of assistants which such specialized work as this really requires. We were forced to take workers who were inexperienced in this line and train them, with the result that we have only been able to get efficient service during the latter half of the twelve months during which the work has been in progress. The training of the staff has often made it difficult for the chief recataloger to give adequate time to the solution of problems which necessarily arise in connection with any such piece of reorganization.

The possibilities for service are not limited to the Library; our service should be extended to those engineers who are groping for the best methods of indexing and classifying engineering literature. Many requests have already come for help along these lines, which opens up a field of work not only much needed but which must be developed if our influence, our methods and our material are to reach all members of the engineering field.

9 *Care of Duplicates.* In this consolidation of libraries the handling of duplicates form no small part of the work. An effort is constantly being made to dispose of our surplus stock. This means the listing, checking and packing of these books and considerable correspondence relative to their disposal.

The Results to be Gained by Recataloging

1 *Making the Resources of the Library Available.* By the recataloging the varying methods of cataloging and classifying formerly used by the societies are being eliminated, bringing the collection together into a logical whole. Much of the material handled by the cataloging staff this year cannot be called recataloging, because many classes of books now in the Library have not, up to this time, been represented in the catalog. Such difficult work as the cataloging of the state and federal documents is quite new to this Library. Some of the most valuable material covering such subjects as Mining, Geology, Foreign Trade, Water Supply, Road Engineering, etc., is to be found in the reports and bulletins issued by state surveys, commissions and experiment stations.

2 *Unit Subject Catalogs.* The Library will have a catalog which can be printed in small but complete units, small enough to be included in our own society journals. Unlike an alphabetical catalog, the classified catalog now in process of making can be used and printed by subject. It is so arranged that one class such as Hydraulic Engineering is complete in itself and is not scattered under Pumps, Dams, Water Flow, etc. An alphabetical index takes care of Pumps, Dams and Water Flow, while the whole class of Hydraulic Engineering remains as a unit. Should a smaller class be needed, such as Dams, this will also be found to be a complete unit.

3 *Weak Spots in the Collection* will be revealed and records furnished for filling in the gaps. Until the books are combined under one classification it is quite impossible to see wherein the Library is weak.

4 *Establish a System of Classifying Engineering Literature* which can be applied not only to books but also to the indexing of periodicals.

5 *An Alphabetical Key* to the classification will thus be compiled, which, if published, will enable any engineer to index his own library, and his own periodicals, by the most approved international method at a minimum cost. This has never before been accomplished by any library or any individual and its completion will see a real contribution to engineering literature. It is an aid which engineers are seeking.

Book Notes

Industrial Relations Association of America. Proceedings, Annual Convention, Chicago, 1920. Paper, 6 x 9 in., 592 pp., $5.

The papers presented at this conference, held in May 1920, are divided into two groups, one consisting of general problems and the other of those peculiar to specific industries. The collection covers a wide range of topics connected with the relations of workmen and employers.

Engineering Electricity. By Ralph G. Hudson. John Wiley & Sons., Inc., New York, 1920. Cloth, 9 × 12 in., 190 pp., illus., tables, $2.50.

This text represents the lectures given at the Massachusetts Institute of Technology to those technical students who are not specializing in electrical engineering. The course covers the general principles of electrical engineering and magnetism most frequently applied in engineering practice.

Financial Engineering. A Text for Consulting, Managing and Designing and Designing Engineers and for Students. By O. B. Goldman. John Wiley & Sons, Inc., New York, 1920. Cloth, 6 × 9 in., 271 pp., illus., tables, $3.50.

The author of this treatise has in mind the practicing engineer, interested in installing plants that will have the highest financial efficiency, although not necessarily the highest mechanical efficiency. The book is therefore an exposition of methods for determining the comparative value of the things which the engineer must use, and the financial efficiency of undertakings.

Elements of Engineering Thermodynamics. By James A. Moyer, James P. Calderwood and Andrey A. Potter. John Wiley & Sons, Inc., New York; Lond., Chapman & Hall, Ltd., 1920. 216 pp., illus., tables, folded chart, 6 × 9 in., cloth $2.50.

This treatise is an extension of a briefer work entitled Engineering Thermodynamics, by James A. Moyer and F. A. Calderwood. It is intended to bring out the fundamental principles of the subject, particularly for use in technical colleges where special courses on steam turbines, internal-combustion engines, refrigeration and other applications of thermodynamics can be given. Additions and changes have been made to the original material, to make the book better adapted to special requirements.

Fundamental Principles of Electric and Magnetic Circuits. By Fred Alan Fish. First edition. McGraw-Hill Book Co., New York, 1920. Cloth, 6 × 9 in., 194 pp., illus., $2.75.

This volume is intended as an introduction to the study of electric-power machinery and transmission. It discusses the principles that the author considers fundamental, is intended for undergraduate students, and therefore does not go deeply into the physical and mathematical theory of electricity, nor include all the possible variations in conditions which might affect the application of the principles as stated.

Fuel Oil in Industry. By Stephen O. Andros. The Shaw Publishing Company, Chicago, 1920. Cloth, 6 × 9 in., 214 pp., illus., tables, $3.75.

The volume opens with a discussion of the physical and chemical properties of fuel oil, the principles of its combustion, a comparison of coal and oil as fuels and a description of "colloidal" fuel. This is followed by chapters on the storage and distribution of oil, methods of heating, straining and pumping, on the arrangement of boiler furnaces and on types of burners. The remaining portion of the book describes the applications of fuel oil in steamships, locomotives, iron and steel manufacture, heat treating, central stations, the sugar, glass and ceramic industries, and in heating buildings. The treatment is concise and practical rather than theoretical.

Handbook for Heating and Ventilating Engineers. By James D. Hoffman, assisted by Benedict M. Raber. Fourth edition, McGraw-Hill Book Co., New York, 1920. Flexible cloth, 4 × 7 in., 478 pp., illus., tables, $4.50.

Supplement: A Course of Instruction for Technical Schools with Questions, Problems and References. To be used in connection with the Handbook for Heating and Ventilating Engineers—Hoffman; paper, 4 × 7 in., 51 pp.

This volume is intended to fill the need of those engaged in the design and installation of heating and ventilating apparatus for a pocket book covering the entire subject in simple form and containing the tables commonly used. The present edition has been entirely rewritten and reset, and considerably enlarged, to bring it into accord with present practice.

Industrial Housing. With Discussion of Accompanying Activities; Such as Town Planning, Street Systems, Development of Utility Services, and Related Engineering and Construction Features. By Morris Knowles. First edition. McGraw-Hill Book Co., Inc., New York, 1920. Cloth, 6 × 9 in., 408 pp., illus., tables, $5.

The author endeavors to develop the things which must be considered in order to provide not merely houses but homes, with all the attendant attributes of a living and livable town, and his book is the result of a realization that the preparation of a successful town plan and the development of a contented industrial community are dependent upon the action of many agencies and require the coördination of men of many professions. Although the work of an engineer, the book is not a treatise on technical practice, but is intended to represent the views of experts in architecture, town planning, landscape gardening, engineering, sanitation, public utilities, building, real estate, civics and business, for whom, together with city officials, the book is intended.

Tin, Sheet-Iron and Copper-Plate Worker. By Leroy J. Blinn. New enlarged edition. Henry Carey Baird & Co., Inc., New York, 1920. Cloth, 5 × 8 in., 334 pp., illus. tables, $3.

A revised edition of a well-known work on the working of sheet metal, containing rules for laying out work, recipes for solders, cements, and lacquers, as well as the tables and other data used by the mechanic.

The Ownership and Valuation of Mineral Property. Being an Elementary Treatise on the Nature of Mineral Interests and Royalties, and the Correct Method of Valuing such Property for the Purpose of Sale, Probate, and Rating and Taxation, together with a Statement of the Law relating to Rating and Taxation. By Sir R. A. S. Redmayne and Gilbert Stone. Longmans, Green and Co., New York, 1920. Cloth, 6 × 9 in., 256 pp., $4.50.

The primary object of this book is to assist the mining expert who desires to have available a statement of the interests involved and the mode of valuing those interests in the mining industry generally. The work consequently contains, in addition to chapters on royalties and valuation, a general explanation of the law relating to mining interests, way leaves and subsidence, and also the law relating to the rating and taxation of mineral properties.

The Practice of Lubrication. An Engineering Treatise on the Origin, Nature and Testing of Lubricants, their Selection, Application and Use. By T. C. Thomsen. First edition. McGraw-Hill Book Co., New York, 1920. Cloth, 6 × 9 in., 607 pp., illus., $6.

After a brief, practical description of commercial oils, fats and greases, the author describes the chemical and mechanical tests used and explains the laws of friction. Methods of lubrication are then described. The greater portion of the book is given to a discussion of the selection and use of lubricants for specific types of machinery, covering all classes of machines. Oil recovery, purification, storage and distribution, oils for cutting and for transformers are also discussed. The viewpoint throughout is that of the engineer rather than the chemist.

THE ENGINEERING INDEX

(Reg. U. S. Pat. Off.)

THE ENGINEERING INDEX presents each month, in conveniently classified form, items descriptive of the articles appearing in the current issues of the world's engineering and scientific press. At the end of the year the monthly installments are combined and published in book form, this annual volume having regularly appeared since 1906. In the preparation of the Index by the engineering staff of The American Society of Mechanical Engineers some 1200 technical publications received by the Engineering Societies Library (New York) are regularly reviewed, thus bringing the great resources of that library to the entire engineering profession.

Photostatic copies (white printing on a black background) of any of the articles listed in the Index may be obtained at a price of 25 cents per page, plus postage. A separate print is required for each page of the larger periodicals, but wherever possible two small or medium-sized pages will be photographed together on the same print. The bill will be mailed with the print. When ordering photostats identify the article by quoting from the Index item: (1) Title of article; (2) Name of periodical in which it appeared; (3) Volume, number, and date of publication of periodical; (4) Page numbers. Orders should be sent to the Engineering Societies Library, 29 West 39th Street, New York.

ACCIDENT PREVENTION

Foundries. Coöperative Methods for Preventing Foundry Accidents, R. A. Salisbury. Iron Age, vol. 106, no. 20, Nov. 11, 1920, pp. 1268–1269. Committee system of organization including employees is suggested. Paper read before Nat. Safety Council.

Organization for. Employees Rewarded for Self-Protection. Iron Age, vol. 106, no. 19, Nov. 4, 1920, pp. 1189–1191, 4 figs. Organization for accident prevention at plant of Joseph T. Ryerson & Son. One of features is offering prizes to employees with safety records.

ACCIDENTS

Building Construction. Keeping Track of Accidents, F. A. Davidson. Bul. Associated Gen. Contractors, vol. 11, no. 10, Oct. 1920, pp. 14–16, 2 figs. Systematic method for checking safety. Report adopted by Construction Section of National Safety Council.

Foundries. Dangers in Casting. Metal Industry (Lond.), vol. 17, no. 17, Oct. 22, 1920, pp. 323–325. Extracts from annual report of British Chief Inspector of Factories for 1919.

Railway Shops. Shop Accidents, J. A. McNally. Ry. Rev., vol. 67, no. 19, Nov. 6, 1920, pp. 715–716. Costs of accidents in railway shops. From records of Wabash Railroad.

Recording of. Standard Method of Recording Construction Accidents. Eng. News-Rec., vol. 85, no. 18, Oct. 28, 1920, pp. 845–847, 3 figs. Argument and instructions for compiling accident statistics formulated by Construction Section of National Safety Council.

ACCOUNTING

Amortization of War Facilities. The Amortization of War Facilities—II, Arnold F. Van Pelt. Indus. Management, vol. 60, no. 5, Nov. 1920, pp. 345–351. Practical examples of tax relief through amortization.

ADSORPTION

Colloidal. Colloidal Adsorption, Arthur Mutscheller. Jl. Am. Chem. Soc., vol. 42, no. 11, Nov. 1920, pp. 2142–2160, 4 figs. Experimental study of migration velocity of anions as influenced by presence of reversible colloids, concentration of anions and cations as influenced by presence of reversible colloids, etc.

AERIAL PHOTOGRAPHY

Uses in War and Peace. Aircraft Photography in War and Peace, H. Hamshaw Thomas. Jl. Royal Soc. Arts, vol. 68, nos. 3543, 3544, Oct. 15 and 22, 1920, pp. 749–753 and 763–766. Oct. 15: Taking and production of aeroplane photographs. Cantor lectures; Oct. 22: Uses of aerial photography for securing military information. Graphic record of results of operations.

AEROPLANE ENGINES

B. M. W. IIIa. The 185-Hp. Bavarian Aeroplane Engine B.M.W. IIIa (Der 185 PS Bayern-Flugmotor B.M.W IIIa), Otto Schwager. Motorwagen, vol. 23, nos. 22, 23 and 24, Aug. 10, 20 and 31, 1920, pp. 399–404, 421–425 and 441–445, 14 figs. Six-cylinder engine with 150 mm. bore and 180 mm. stroke constructed along lines of the Mercedes engine, but differing from this, however, in the high degree of compression (6.5), and in the construction of the carburetor, in which the output of 185 hp. remains unchanged up to altitude of three km. Results of experiments are given in tabular form showing efficiency of aeroplane.

Fuels for. See GASOLINE, Alcogas Fuel vs.

Ignition. See IGNITION.

German. Development of German Aircraft Engines, Otto Schwager. Aviation, vol. 9, no. 6, Oct. 15, 1920, pp. 186–189, 4 figs. (Concluded.) Translated from Technische Berichte.

Machining. Machining Airplane Engine Parts. Machy. (N.Y.), vol. 27, no. 3, Nov. 1920, pp. 233–238, 11 figs. Tooling equipments and special indexing work-holding fixture used in connection with turret lathe practice of Alfred Herbert, Ltd., Coventry, England.

Rotary. French Rotary Airplane Engine Uses a Variable Stroke, W. F. Bradley. Automotive Industries, vol. 43, no. 18, Oct. 28, 1920, pp. 862–863, 2 figs. Damblanc type in which compression is changed by varying length of stroke.

Superchargers. Experiments with and Practical Use of Superchargers in Germany, Eric Hildesheim. Automotive Industries, vol. 43, no. 17, Oct. 21, 1920, pp. 810–816, 13 figs. Translated from Zeitschrift des Vereines Deutscher Ingenieure, Motorwagen and Flugsport.

Supercharging. Aeroplane Performances as Influenced by the Use of a Supercharged Engine, George De Bothezat. Aerial Age, vol. 12, no. 6, Oct. 18, 1920, pp. 174–179, 2 figs. Equations for calculating ceiling.

AEROPLANES

All-Metal. All-Metal Airplane Comprises Novel Engineering Features. Automotive Industries, vol. 43, no. 17, Oct. 21, 1920, pp. 808–809, 2 figs. Construction and performance of JL all-metal aeroplane. Chief mechanical features of design are self-supporting, deep sectioned, internally trussed wings.

The Short All-Metal "Silver Streak." Aviation, vol. 9, no. 7, Nov. 1, 1920, pp. 217–219, 3 figs. Specifications: Engine, Siddelay Puma; b.hp., 260; surface, 370, sq. ft.; span, 37 ft. 6 in.; length overall, 26 ft. 5 in.; height, 10 ft. 6 in.; total weight, 2870 lbs.; speed, maximum, 120 m.p.h.; climb, 10,000 ft. in 11 min.

British Air Ministry Competition. The Small Airplanes of the British Competition. Aviation, vol. 9, no. 6, Oct. 15, 1920, pp. 193–196. First report on British Air Ministry competition for commercial aircraft by Edward P. Warner, acting technical assistant in Europe of National Advisory Committee for Aeronautics.

Control Surfaces. The Design of Aeroplane Control Surfaces with Special References to Wing Ailerons, H. B. Irving. Eng., vol. 110, nos. 2858–2860, Oct. 8, 15, and 22, 1920, pp. 461–463, 493–494, and 527–528, 19 figs. Oct. 8: Aerodynamic properties of control surfaces. Factors which govern controlability of aeroplanes; Oct. 15: Comparison of efficiencies of control of ailerons on wings with differently shaped tips; and Oct. 22: Graphs showing rolling moment and hinge moment for ailerons of various chords.

Chassis, Retractable. Retractable Chassis as an Aid to Aeroplane Speed and Efficiency, Jas. V. Martin. Aerial Age, vol. 12, no. 10, Nov. 15, 1920, p. 274, 2 figs. Importance of retracting aeroplane chassis to increase speed. Tests are quoted in which speed was increased 30 miles an hour when chassis was retracted and extended.

Cost of Operating. The Operation of Civil Aircraft in Relation to the Constructor, H. White-Smith. Flight, vol. 12, no. 42, Oct. 14, 1920, pp. 1079–1088. Detailed study of cost of operating commercial service.

Dayton-Wright. The Dayton-Wright R. B. Racer. Aviation, vol. 9, no. 6, Oct. 15, 1920, pp. 190, 1 fig. Dimensions: Span, 21 ft. 2 in.; overall length, 22 ft. 8 in.; total weight, loaded, 1850 lb.; cruising radius, 275 miles; ceiling, 15,000 ft.

Design. Analytical Process for Calculating the Polar Equation of an Aeroplane (Procédés analytiques pour le calcul des polaires d'avions), Maurice Le Sueur. L'Aérophile, vol. 28, nos. 15–16, Aug. 1–15, 1920, pp. 226–229. Analytical method claimed to be equally as precise as graphic method, and more rapid than the latter.

Flight, Conditions Governing. The Aerotechnical Institute of St. Cyr. Sci. Am. Monthly, vol. 2, no. 3, Nov. 1920, pp. 260–263, 110 figs. Apparatus for testing mechanical conditions governing flight of airplanes.

German Types. Linke-Hofmann Giant Aeroplanes—Type R-11. Aeronautics, vol. 19, no. 364, Oct. 7, 1920, p. 260. Multi-engined aeroplanes with engines centralized as one unit, developed by Linke-Hofmann Aeroplane Co., of Breslau, Germany.

Junkers. Cause of the Superiority of the Junkers Aeroplanes. (Was macht die Junkers-Flugzeuge überlegen). Luftfahrt, vol. 24, no. 9, Sept. 2, 1920, pp. 131–133, 5 figs. Said to be due partly to exclusive use of light metal, but principally to use of suspended, strutless aerofoils.

Laird Swallow. The Laird "Swallow." Aerial Age, vol. 12, no. 9, Nov. 8, 1920, pp. 253 and 259, 3 figs. Specifications: Span, 36 ft.; overall length, 23 ft. 4 in.; overall height, 8 ft. 8 in.; total supporting area, 324 sq. ft.; total weight, 1750 lb.; range at full speed, 255 miles, maximum speed, 86 m.p.h.; ceiling, 17,000 ft.

Landing Stations. Landing Fields are a Major Problem Development of Air Traffic. Automotive Industries, vol. 43, no. 19, Nov. 4, 1920, pp. 928–929. Present situation and suggested methods for improvement.

Martin Bomber. Trans-Oceanic Airplane. Sci. Am., vol. 123, no. 19, Nov. 6, 1920, pp. 471, 2 figs. Seven-ton Martin bomber under test by U. S. Army. Engine's speed is 2,000 r.p.m. and propeller speed 1,000.

Single vs. Twin-Engined. A Comparison of the Flying Qualities of Single and Twin-Engined Aeroplanes, R. M. Hill. Flight, vol. 12, no. 44, Oct. 28, 1920, pp. 1134–1136, and also Aeronautics, vol. 19, no. 367, Oct. 28, 1920, pp. 307–309. Comparison from pilot's point of view. Paper read before Roy. Aeronautical Soc.

Small Machines. De Pischof's "Avionnette." Aeronautics, vol. 19, no. 364, Oct. 7, 1920, p. 260, 1 fig.

NOTE.—The abbreviations used in indexing are as follows:
Academy (Acad.)
American (Am.)
Associated (Assoc.)
Association (Assn.)
Bulletin (Bul.)
Bureau (Bur.)
Canadian (Can.)
Chemical or Chemistry (Chem.)
Electrical or Electric (Elec.)
Electrician (Elecn.)
Engineer[s] (Engr.[s])
Engineering (Eng.)
Gazette (Gaz.)
General (Gen.)
Geological (Geol.)
Heating (Heat.)
Industrial (Indus.)
Institute (Inst.)
Institution (Instn.)
International (Int.)
Journal (Jl.)
London (Lond.)
Machinery (Machy.)
Machinist (Mach.)
Magazine (Mag.)
Marine (Mar.)
Materials (Matls.)
Mechanical (Mech.)
Metallurgical (Met.)
Mining (Min.)
Municipal (Mun.)
National (Nat.)
New England (N. E.)
Proceedings (Proc.)
Record (Rec.)
Refrigerating (Refrig.)
Review (Rev.)
Railway (Ry.)
Scientific or Science (Sci.)
Society (Soc.)
State names (Ill., Minn., etc.)
Supplement (Supp.)
Transactions (Trans.)
United States (U. S.)
Ventilating (Vent.)
Western (West.)

ENGINEERING INDEX (Continued)

Specifications: Span, 5.20 m.; total height, 1.30 m.; total length, 3.52 m.; weight empty, 102 kg.; engine, 16 hp. Clerget; maximum speed, 95–97 km. per hour; maximum height, 300 m.

Stress Analysis. Airplane Stress Analysis, A. F. Zahm and L. H. Crook. Nat. Advisory Committee for Aeronautics, report no. 82, 1920, 70 pp., 42 figs. Theory of aeroplane stress analysis taking into consideration forces within engine and propeller.

Sperry Amphibious Triplane. The Sperry Amphibious Triplane. Aviation, vol. 9, no. 7, Nov. 1, 1920, pp. 222–224, 2 figs. Specifications: Wing span, 48 ft.; depth of wing chord, 60 in.; gap between wings, 60 in.; length overall, 31 ft. 6 in.; height, 15 ft. 4 in.; total supporting surface, 678 sq. ft.; total weight, 5056 lbs.; engine, Liberty 12-cylinder V type 400 hp.; speed, 91 m.p.h.

Waterman Type. Waterman Type 3-L400 Airplane. Aviation, vol. 9, no. 6, Oct. 15, 1920, pp. 191–192, 2 figs. Dimensions: Speed, maximum, 126 m.p.h.; crusing speed, 105 m.p.h., engine, 400 hp. Liberty, weight, loaded, 4135 lb., climb, 10,000 ft. in 8 min.

Wings. The Handley Page Wing. Flight, vol. 12, no. 44, Oct. 28, 1920, pp. 1123–1125, 4 figs. Account of first public demonstration of patented high-lift wing.

The Handley Page Wing Patent. Aviation, vol. 9, no. 6, Oct. 15, 1920, pp. 197–199, 6 figs. Object of invention is to provide construction whereby burbling effect on back or upper surface of forward portion of wing can be overcome, so that same lift can be obtained at slower speeds than is now possible even when wing is inclined at greater angle to air.

AIRSHIPS

Commercial. The Commercial Airship—Its Operation and Construction, Trevor Dawson. Eng., vol. 110, no. 2860, Oct. 22, 1920, pp. 558–560. Airplane versus airship. Airship is found more advantageous for commercial service, and its traffic possibilities are pointed out. (Abstract.) Paper read at Air Conference, London, Oct. 14, 1920.

Rigid. The Aerial Cruiser. Sci. Am., vol. 123, no. 16, Oct. 16, 1920, pp. 400, 409 and 412, 3 figs. Particulars: Gross displacement, 38.25 tons; disposable lift, 17.80 tons; total b.hp. at full power, 1000; range in miles, full power, 3900; maximum height attainable with crew and stores, 17,000 ft.

[See also BALLOONS.]

ALCOHOL

Ethyl, from Wood Waste. The Manufacture of Ethyl Alcohol from Wood Waste, G. H. Tomlinson. Dominion of Canada, bul. no. 7, 1919, 9 pp. Chemical processes.

Waste Sulphite Liquor as Source. Canadian Waste Sulphite Liquor as a Source of Alcohol, Vernon K. Krieble. Dominion of Canada, report no. 5, 1919, 14 pp., 2 figs. A dozen representative Canadian sulphite liquors were analyzed. Results showed that best liquors contained as high a percentage of sugar as those produced in Europe. Yield from Canadian sulphite liquors is estimated at at least one per cent of alcohol by volume.

[See also AUTOMOBILE FUELS, Alcohol.]

ALLOY STEELS

Non-Expanding. Important Swiss Discovery Affecting Watchmaking. Commerce Reports, no. 260, Nov. 4, 1920, p. 569. C. E. Guillaume, director of International Bureau of Weights and Measures announces discovery of alloy steel which will experience no changes with variation in temperature. Alloy is a nickel steel with 12 per cent chrome.

Uranium and Chrome-Vanadium. Uranium as a Structural Steel Alloy, Hugh S. Foote. Ry. Mech. Engr., vol. 94, no. 11, Nov. 1920, pp. 695–696. Characteristics of uranium steel. Static and dynamic tests of uranium and chrome-vanadium steels.

ALLOYS

Molybdenum, Cobalt and Chromium. The Analysis of Molybdenum, Cobalt, and Chromium Alloys, J. R. Camp and J. W. Marden. Jl. Indus. and Eng. Chem., vol. 12, no. 10, Oct. 1920, p. 998. Results of series of analyses made on samples of metal obtained by alunimothermic reduction method.

Ternary. Ternary Alloys and the Equivalence Coefficients (Les alliages ternaires et les coefficients d'equivalence), Léon Guillet and Albert Portevin. Revue de Métallurgie, vol. 17, no. 8, Aug. 1920, pp. 561–567, 4 figs. Technical study. Special reference made to copper-aluminum-zinc alloys.

[See also ALUMINUM ALLOYS.]

ALTERNATORS

See ELECTRIC GENERATORS, A. C., Slow-Speed.

ALUMINUM

Atomic Weight. A Revision of the Atomic Weight of Aluminum. The Analysis of Aluminum Bromide. Preliminary Paper, Theodore W. Richards and Henry Krepelka. Jl. Am. Chem. Soc., vol. 42, no. 11, Nov. 1920, pp. 2221–2232, 1 fig. Synthesis and analysis of pure aluminum bromide. Atomic weight for aluminum is computed at 26.963.

Automobile Parts. Machining Aluminium Automobile Parts. Machy. (Lond.), vol. 17, no. 422, Oct. 28, 1920, pp. 97–101, 9 figs. Account of recent practice.

Dust, Explosibility of. A Disastrous Explosion of Aluminum Dust, David J. Price. Chem. & Metallurgical Eng., vol. 23, no. 19, Nov. 10, 1920, pp. 915–919, 7 figs. Description of investigation by federal and state officials of causes leading to aluminum-dust explosion and manner in which explosion occurred, and results of this investigation.

Nickel Plating of. Nickel-Plating Aluminum and Alloys. Sci. Am. Monthly, vol. 2, no. 3, Nov. 1920, p. 267. It was found in tests that sheet metal treated with fine ground sand and under pressure of 1500 grams per sq. cm. could be kept in good state if wrapped in sheet of filter paper for 30 days before being nickel-plated. Sheets of metal treated with sand blast under these conditions were nickel-plated up to 0.04 mm. Translated from Revue de Métallurgie.

ALUMINUM ALLOYS

Analysis of. A Rapid and Systematic Method for the Analysis of Light Aluminium Casting Alloys, Russell M. Berry. Jl. Indus. and Eng. Chem., vol. 12, no. 10, Oct. 1920, pp. 998–1000. Method developed at U. S. Navy Yard, Philadelphia, Pa.

No. 12 Alloy. Experiments in Manufacturing No. 12 Alloy, Robert J. Anderson. Chem. & Metallurgical Eng., vol. 23, no. 18, Nov. 3, 1920, pp. 883–887, 4 figs. It is concluded from experiments that No. 12 alloy may be conveniently and economically prepared by charging aluminum ingot, No. 12 ingot and scrap and copper-rich alloy into melting furnace, and that there is no advantage in any other procedure.

APPRENTICES, TRAINING OF

Engineering Apprentices. The practical Training of Engineering Apprentices [Die praktische Ausbildung der Ingenieurlehrlinge (Praktikanten)]. Betrieb, vol. 2, no. 15, Aug. 1920, pp. 413–415. Advice to machine industrials. Proposal of the German Committee for Technical Instruction.

German Works. The Apprentice School of the Thyssen & Co. Machine Factory, Mülheim-Ruhr (Aus der Lehrlingsschule der Maschinenfabrik Thyssen & Co., Mülheim-Ruhr, E. W. Seyfert. Werkstattstechnik, vol. 14, no. 15, Aug. 1, 1920, pp. 409–420. Conditions in training school are described which are said to be particularly interesting partly because it is a happy medium between municipal continuation schools and the purely technical training school, and partly because of its curriculum, effort being made to bring instruction in closest relationship with vocation of apprentice in order to stimulate his interest in learning. Sheets showing plan of instruction for the different classes are reproduced.

Machinists. A Worth-While Training Department, L. C. Morrow. Am. Mach., vol. 53, no. 20, Nov. 11, 1920, pp. 893–896, 3 figs. Methods at shop of American Tool Works, Co., Cincinnati.

Training Apprentices for Permanent Jobs, Norman G. Shidle. Automotive Industries, vol. 43, no. 19, Nov. 4, 1920, pp. 923–925, and p. 929, 3 figs. Training course for machinists operated for 40 years at works of Warner & Swasey Co., Cleveland.

Methods. Modernizing the Apprenticeship, Erik Oberg. Machy. (N.Y.), ol. 27, no. 3, Nov. 1920, pp. 220–224, 7 figs. Review of methods used by Taft-Pierce Mfg. Co., Woonsocket, R. I., in training apprentices along broad, comprehensive lines, intended to ultimately fit them for important position in mechanical industries.

Programs of Apprenticeship and Special Training in Representative Corporations—IV, J. V. L. Morris. Am. Mach., vol. 53, no. 19, Nov. 4, 1920, pp. 847–852, 8 figs. Methods of Westinghouse Electric Mfg. Co., East Pittsburgh, Pa.

Secondary Technical Education, F. H. Sexton. Jl. Eng. Inst. Canada, vol. 3, no. 11, Nov. 1920, pp. 505–509. Discussion of present and proposed methods of training in industry: vocational training, what it has accomplished in Great Britain and America, and part to be played by engineers.

ARCHES

Brick. Arch Brick Work, A. D. Williams. Iron Age, vol. 106, no. 20, Nov. 11, 1920, pp. 1264–1265, 1 fig. Formulæ and tables for fantail or taper arches.

ASPHALT

Gas vs. Oil for Melting. Taking All Factors into Consideration, Gas can be Proved Least Expensive as Well as Most Economical Fuel for Asphalt Melting C. H. Kallstedt. Am. Gas. Eng. Jl., vol. 113, no. 18, Oct. 30, 1920, pp. 345–348 and 350–351. Comparative costs of gas and oil. Advantages of using gas.

Refineries. The Largest Asphalt Refinery in the World. Mun. & County Eng., vol. 59, no. 4, Oct. 1920, pp. 130–132, 4 figs. Refinery operated by Texas Co. at Port Neches, Texas.

ATMOSPHERE

Electrical Phenomena at High Levels. Electrical Phenomena Occurring at High Levels in the Atmosphere, C. Chapman. Jl. Instn. Elec. Engrs. (Supp.), vol. 57, part 2, Oct. 1920, pp. 209–216 and (discussion) pp. 217–222, 4 figs. General outline of subjects based on published reports of observations.

AUTOGENOUS WELDING

Purity of Oxygen. Investigation of the Purity of Oxygen for Autogenous Welding (Untersuchung der Reinheit des Sauerstoffs für Autogenschweisserein). Autogene Metallbearbeitung, vol. 13, nos. 14 and 15, July 15 and Aug. 1, 1920, pp. 157–162 and 175–177, 5 figs. Includes two tables giving costs of autogenous welding with pure oxygen and the influence of a lesser degree of purity on welding costs and on danger of explosion. Discusses the Dräger device for protection against burning out.

AUTOMOBILE ENGINES

Cam Grinding. A New Attachment for Grinding of Cams. Automotive Industries, vol. 43, no. 19, Nov. 4, 1920, pp. 921–922, 3 figs. Landis cam-grinding attachment.

Ignition. See IGNITION.

Starters. Electric Starting and Lighting of Automobiles (Éclairage et démarrage électriques des automobiles). Génie Civil, vol. 77, no. 14, Oct. 2, 1920, pp. 273–276, 5 figs. Bicompound dynamo built by Bleriot Works, Paris.

Impulse Starters. Automobile Engr., vol. 10, no. 143, Oct. 1920, pp. 417–418, 6 figs. Notes on new M-L device.

Tylor-Ricardo. The Tylor-Ricardo Engine. Automobile Engr., vol. 10, no. 143, Oct. 1920, pp. 386–393, 13 figs. Four-cylinder power unit for heavy vehicles. Description and results of road tests.

AUTOMOBILE FUELS

Acetol. New Motor Fuel in South Africa, Charles J. Pisar. Commerce Reports, no. 252, Oct. 26, 1920, p. 411. Particulars regarding acetol, a mixture of alcohol and ether with other ingredients.

Alcohol. Possible New Sources of Power Alcohol, C. Simmonds. Nature (London), vol. 106, no. 2660, Oct. 21, 1920, pp. 244–245. Report by Fuel Research Board, department of Scientific and Industrial Research.

Gasoline Substitute. Alternative Fuels. Eng., vol. 110, no. 2860, Oct. 22, 1920, pp. 543–544. Editorial comment on conflict in views presented at Fuel Section meetings of Imperial Motor Transport Conference held in London during Commercial Vehicle Exhibition.

Mixtures. Fuel Mixtures on London 'Buses, G. J. Shave. Motor Traction, vol. 31, no. 817, Oct. 25, 1920, pp. 493–494, 2 figs. Experiments carried out by London General Omnibus Co. Alcohol benzole, alcohol-ether, and alcohol-ether-benzol mixtures have been investigated.

[See also GASOLINE.]

AUTOMOBILES

Air Brakes. Air Brakes for the Automobile, C. W. Geiger. Sci. Am., vol. 123, no. 19, Nov. 6, 1920, pp. 467 and 480, 2 figs. System tested at Safety First Exposition held in conjunction with Nat. Traffic Officers' Convention at San Francisco. Air pressure is obtained from one cylinder of engine and is automatically maintained by means of accumulator valve with only one moving part.

Quantity Production. Machine Tool Practice as Applied to Motor-Car Production. Machy. (Lond.), vol. 17, no. 421, Oct. 21, 1920, pp. 68–75, 13 figs. Review of production methods employed by Vulcan Motor & Eng. Co. (1906), Ltd., Southport, England.

Warming Apparatus. Motor-Car Warming Apparatus. Eng., vol. 110, no. 2858, Oct. 8, 1920, pp. 472, 5 figs. Apparatus designed and constructed by Arc & General Equipment, Ltd., Engineers, London.

Wheels. Single-Disc Metal Wheels, A. L. Putnam, Jl. Soc. Automotive Engrs., vol. 7, no. 5, Nov. 1920, p. 437 and (discussion) p. 442. Advantages.

Wire Wheels, C. S. Walker. Jl. Soc. Automotive Engrs., vol. 7, no. 5, Nov. 1920, pp. 441–442, 4 figs. Advantages and disadvantages.

Wood Truck Wheels, S. Vance Lovenstein. Jl. Soc. Automotive Engrs., vol. 7, no. 5, Nov. 1920, pp. 438–440 and (discussion) pp. 442–445, 2 figs. Advantages and disadvantages. Results of strength tests.

AVIATION

Aerial Mail Service. Aerial Postal Service (La voie postale aérienne), Georges Brunel. L'Aérophile, vol. 28, nos. 15–16, Aug. 1–15, 1920, pp. 240–245. Survey of developments throughout the world.

Mail Transport, P. L. Holmes. Aeronautics vol. 19, no. 366, Oct. 21, 1920, pp. 293–294. Coöperation of aircraft and surface craft.

Aerial Transportation. Time Table and Tariff of Air Companies Operating at Paris. Aeronautics, vol. 19, no. 364, Oct. 7, 1920, p. 262. There are four companies operating between Paris-London; one between Paris and Geneva; one between Toulouse and Bordeaux; two between Paris and Brussels; one between Toulouse and Montpellier; and one between Toulouse and Agen.

Alaskan Expedition. The Alaskan Flying Expedition. Flying, vol. 9, no. 10, Nov. 1920, pp. 626–630, 3 figs. Records of flight.

British Air Ministry. The Air Conference. Eng., vol. 110, nos. 2859 and 2860, Oct. 15 and 22, 1920, pp. 512–515 and 528–532. Proceedings of Air Conference called by Air Ministry for purpose of discussing technical and economic problems connected with aviation. (Abstract.)

Civil. Civil Aviation and Air Services, S. H. Sykes. Eng., vol. 110, no. 2859, Oct. 15, 1920, pp. 524–526. Growth and present position of air mail passenger and goods services in British Empire, France and United States. (Abstract.) Paper read at Air Conference at London, Oct. 12, 1920.

Contests. Two Great Aviation Contests in 1920 (Deux grandes épreuves d'aéronautique de 1920). Génie Civil, vol. 77, no. 17, Oct. 23, 1920, pp. 325–

ENGINEERING INDEX (Continued)

328, 8 figs. Contest for the Gordon-Bennett Cup held on Sept. 28, and the Buc Meeting, Oct. 8–10.

Key West-Havana Route. Key West-Havana Route Inaugurated. Aviation, vol. 9, no. 7, Nov. 1, 1920, pp. 226–227 and p. 230, 3 figs. Aircraft used is development of F-5-L flying boats which United States Government produced during the war for extended anti-submarine patrols both in home waters and in North Sea.

[See also FLIGHT.]

AVIATORS

Physiological Phenomona at High Altitudes. Aviators at High Altitudes (Les aviateurs aux hautes altitudes), Jacques Boyer. Nature (Paris), no. 2422, Sept. 4, 1920, pp. 145–148, 3 figs. Physiological experiments at French Aerotechnical Inst.

B

BALLOONS

Dilatable. Dilatable Balloons, James F. Boyle. Aviation, vol. 9, no. 6, Oct. 15, 1920, pp. 184–186, 6 figs. Balloons recently built and tested by War Department.

Hydrogen-Helium Mixtures for. Inflammability of Jets of Hydrogen and Inert Gas, P. G. Ledig. Jl. Indus. & Eng. Chem., vol. 12, no. 11, Nov. 1920, pp. 1098–1100, 4 figs. Experimental work to determine maximum amount of hydrogen which can be used with helium in balloons without losing advantage of noninflammability. Up to 18 to 20 per cent of helium was found to be safe proportion.

BARGES

Adjustable Prow. French Devise Adjustable Prow to Increase Speed of Barges. Eng. News-Rec., vol. 85, no. 18, Oct. 28, 1920, pp. 851–852, 2 figs. Resistance lowered 23 per cent in tests made with folding panels that sharpen barge's flat bow. Translated from Annales des Ponts et Chaussées.

BATTERIES

Clark Standard Cell. The Two Common Failures of the Clark Standard Cell, E. C. McKelvy and M. P. Shoemaker. Sci. Papers, Bur. of Standards, no. 390, July 21, 1920, pp. 409–420, 8 figs. Cracking at amalgam terminal is remedied by employing platinum wire previously subjected for a short time to the action of hot ten per cent zinc amalgam, using lead sealing-in glass. Interruption of circuit by gradual formation of gas in amalgam limb is reduced by using smallest excess of crystals required to insure saturation at highest temperature at which cell is likely to be used.

Dry Cells, Testing. Automatic Apparatus for Intermittent Testing, G. W. Vinal and L. M. Ritchie. Technologic Papers, Bur. of Standards, no. 171, July 22, 1920, 7 pp. 6 figs. Apparatus devised at Bureau of Standards for making tests of dry cells and storage batteries. It is applicable to any form of intermittent test requiring closing of electrical circuits at regular time intervals.

New Cell. A New Electric Battery (Une nouvelle pile électrique), A. Troller. Nature (Paris), no. 2424, Sept. 18, 1920, pp. 180–181, 1 fig. Leclanché type with electrodes arranged to permit depolarization of oxygen of atmosphere.

BEAMS

Bending Moments. A Self-Checking String Polygon, Theodore Bleckmann. Eng. News-Rec., vol. 85, no. 19, Nov. 4, 1920, pp. 880–881, 3 figs. Graphical method in which paralleling is replaced by measurement.

Cantilever. The Calculation of the Deformation of Cantilever. Beam Systems (Beitrag zur Berechnung der Formänderung von Kragträgersystemen), Eduard Cecerle. Eisenbau, vol. 11, no. 17, Sept. 3, 1920, pp. 296–313, 14 figs. Method according to which the elastic weights are calculated from the internal forces (deformations) due to load (change of temperature, etc.); with these weights the described reciprocal beam system is loaded; and line of moments of the elastic weights is the bending line. Includes table for calculation of bending line.

[See also GIRDERS.]

BEARINGS, BALL

Roller and. What is the Difference Between Roller and Ball Bearings, A. Danielson. Am. Mach., vol. 53, no. 19, Nov. 4, 1920, pp. 857–858, 5 figs. Suggestions for definite classification of these two types.

BELTING

Substitutes. Investigation of Substitute Belts (Untersuchung von Ersatzriemen), H. Schlesinger and M. Kurrein. Werkstattstechnik, vol. 14, nos. 14 and 15, July 15, and Aug. 1, 1920, pp. 385–388 and 420–426, 18 figs. Account of tests on various types of belts to determine their adaptability, etc., and description of test arrangements. Results are given in tables and charts and show that braided belts give the poorest and twill texture the best results. Report from machine-tool testing station of the Berlin Technical Academy.

BENZOL

Recovery from Coal Gas. The Recovery of Vapours from Gases Particularly of Benzene and Toluene from Coal Gas, Harold S. Davis and Mary Davidson Davis. Dominion of Canada, report no. 2, 1918, 15 pp., 2 figs. Results of research carried out in University of Manitoba, and of tests conducted at Light Oil Recovery Plant of Toronto Chemical Co.

BLAST-FURNACE GAS

Cleaning. Cleaning Blast-Furnace Gas, A. Hutchinson and E. Bury. Eng., vol. 110, no. 2857, Oct. 1, 1920, pp. 453–456, 4 figs. Rough-cleaning of blast-furnace gas at Skinningrove by the Lodge Electrostatic Process. Paper read before Iron & Steel Inst.

Power Production from. The Production of Power from Blast-Furnace Gas, S. H. Fowles. Jl. Instn. Elec. Engrs., vol. 58, no. 292, June 1920, pp. 431–436, and (discussion) pp. 437–463, 3 figs. Survey of old and new methods of utilization of waste heat.

BLAST FURNACES

Heat Supplied to. The Effect of Heat Supplied to the Blast Furnace, W. W. Hollings. Eng., vol. 110, no. 2857, Oct. 1, 1920, pp. 459–460. Variations in heat supplied to blast furnace, and their effect on fuel consumption. Paper read before Iron & Steel Inst.

Large Hearths. Development of Large Furnace Hearth, Walter Mathesius. Blast Furnace & Steel Plant, vol. 8, no. 11, Nov. 1920, pp. 588–592, 6 figs.; Chem. & Metallurgical Eng., vol. 23, no. 18, Nov. 3, 1920, pp. 867–872, 6 figs.; Iron Trade Rev., vol. 67, no. 18, Oct. 28, 1920, pp. 1211–1213, 6 figs.; and Iron Age, vol. 106, no. 18, Oct. 28, 1920, pp. 1106–1109, 1 fig. Wide hearth permits steeper bosh and flatter stack lines with many resulting economies, especially for smelting Mesaba ores. Operating data, construction details and theoretical considerations point to its definite superiority. Paper read before Am. Iron and Steel Inst.

Remodeling. Rebuilt Furnace Conserves Labor. Iron Trade Rev., vol. 67, no. 17, Oct. 21, 1920, pp. 1123–1126, 5 figs. How capacity of furnace of Belfont Iron Works Co., Ironton, O., was increased two-thirds.

Remodeled Blast Furnace at Ironton, Ohio, F. H. Willcox. Blast Furnace & Steel Plant, vol. 8, no. 11, Nov. 1920, pp. 599–602, 3 figs. How capacity of blast furnace has been increased two-thirds.

Stack Design. Designs Stack for Foundry Iron. Iron Trade Rev., vol. 67, no. 16, Oct. 14, 1920, pp. 1068–1070, 4 figs. Bosh is cooled by series of louvers which keep film of water flowing over entire jacket. Big bell suspended from yoke on account of filling system. Charge weighted on floor-type scale.

BOILER FEEDWATER

Automatic Regulator for. An Automatic Feed Regulator. Engr., vol. 130, no. 3380, Oct. 8, 1920, p. 352, 3 figs. Manufactured by A. G. Mumford, Ltd., Colchester, England. Regulator acts directly on feed check valve and relies for its effect on control of leakage past piston connected with valve.

Testing. Simple Methods of Determining Dissolved Gas Content in Boiler-Feed Water, J. R. McDermet and Daniel Wertheimer. Power, vol. 52, no. 18 Nov. 2, 1920, pp. 686–688, 3 figs. Methods which do not require special laboratory glassware or skilled operator.

BOILER FIRING

Lean Gas as Fuel. Lean Gas as Boiler Fuel. Iron Age, vol. 106, no. 20, Nov. 11, 1920, pp. 1261–1262, 1 fig. Low grade coals used in coke ovens and coke utilized in gas producers. Experiments carried on by Société desères de Montrambert et de la Béraudière at St. Étienne, France.

BOILERS

Electrically Heated. Recent Developments of Electrically Heated "Revel" Boilers in Switzerland, E. G. Constam-Gull. Eng., vol. 110, no. 2861, Oct. 29, 1920, pp. 563–565, 4 figs. Revel boiler has overall diameter of 24 in. and total height of 8 ft. It produces 1200 lb. of steam per hour at gage pressure of 225 lb. per sq. in. when supply current is at 500 volts. Efficiency corresponds to evaporation of 2.8 lb. of standard steam per kilowatt-hour. Evaporation and heating of steam is accomplished within immediate vicinity of water level.

Gas-Fired. French Experience with Gas-Fired Boiler Installation Demonstrates Possibility of Complete Combustion of Low B.t.u. Gas Without Preheating Supporting Air, John H. Bartlett, Jr. Am. Gas Eng. Jl., vol. 113, no. 17, Oct. 23, 1920, pp. 321–324, 2 figs. Installation made by French Company, employing patented process and equipment of Surface Combustion Co. of New York.

Use of Gas Fired Boilers, C. M. Grow. Gas Rec., vol. 18, no. 7, Oct. 13, 1920, pp. 39–42. Appliances for domestic and commercial heating on Pacific coast. Paper read before Pacific Coast Gas Assn.

Industrial Code. Rules as Amended Relating to the Construction, Installation, Inspection and Maintenance of Steam Boilers. Bul. no. 14, Industrial Code, State of New York, Dept. of Labor, State Industrial Commission, 148 pp., 33 figs. Rules amended and readopted to become effective July 1, 1920.

Oil-Fired. Soot Deposits in Oil-Fired Boiler, Robert June. Power Plant Eng., vol. 24, no. 22, Nov. 15, 1920, pp. 1061–1063, 2 figs. Description of tests indicating advisability of equipping oil-fired boilers with soot blowers.

Patches. Design of Patches. Universal Engr., vol. 32, no. 4, Oct. 1920, pp. 38–40, 1 fig. Factor diagram for diagonal patch seams on bottoms of horizontal return tubular boilers.

Temperature Measurements. Temperature Measurements with Special Regard to Steam-Boiler Investigations (Einiges über Temperaturmessungen, insbesondere bei Dampfkesseluntersuchungen), H. Hilliger. Zeitschrift für Dampfkessel u. Maschinenbetrieb, vol. 43, nos. 33, 34, 35 and 36, Aug. 13, 20, 27 and Sept. 3, 1920, pp. 249–251, 257–260, 267–269 and 275–276, 14 figs. Discusses work by Knoblauch and Hencky on the accurate technical temperature measurements with liquid and electric thermometers, and other viewpoints and experiences in connection with furnace and steam-boiler investigations.

Through Stays. A Limiting Formula for Long Through Stays, John S. Watts. Boiler Maker, vol. 20, no. 10, Oct. 1920, pp. 297–298, 1 fig. Discussion of method of determining proper sizes of through stays in boilers. Chart developed to simplify calculations.

Tubes. The Constitution and Properties of Boiler Tubes, Albert E. White. Mech. Eng., vol. 42, no. 11, Nov. 1920, pp. 603–606, and p. 618. Experimental investigations carried out at Detroit Edison Co. Causes of failure of boiler tubes were found to be: (1) Failure due to tube brittleness resulting from absorption of hydrogen by metal; (2) failure due to blowholes or other imperfections in metal, and (3) failure due to recrystallization of metal. Further study disclosed that increased carbon content in tubes would insure longer life and safer boiler operation. It is suggested that carbon content should vary between 0.30 and 0.35 per cent.

BORING MACHINES

Heavy-Duty. Heavy-Duty Boring Machine. Machy. (N.Y.), vol. 27, no. 3, Nov. 1920, pp. 259–260, 3 figs. Machining headstock and tailstock castings for ninety-inch driving wheel lathes.

Milling Attachment for. Vertical Boring Mill with Milling Attachment (Karusseldrehwerk mit Fräsvorrichtung), H. Weil. Zeit. des Vereines deutscher Ingenieure, vol. 64, no. 39, Sept. 25, 1920, pp. 793–794, 8 figs. Describes machine with table 4500 mm. in diam. built by the Schiess machine factory, Düsseldorf, and equipped with a special milling attachment. Shows that such special arrangements can be advantageously applied, and that in certain cases they save the installation of a new machine.

BRACKETS

Design. Stresses in Brackets and Their Bolts, Victor M. Summa. Machy. (N.Y.), vol. 27, no. 3, Nov. 1920, pp. 239–241, 4 figs. Formula for computing stresses, bending moment diagrams, etc.

BRASS

Melting with Fuel Oil. Melting Brass with Fuel Oil—I, S. D. Rickard. Metal Industry (N.Y.), vol. 18, no. 10, Oct. 1920, pp. 460–463, 2 figs. Analysis of costs and comparison with other fuels, showing that fuel oil is most economical.

BRIDGES, HIGHWAY

Reconstruction. Strengthening and Reconstructing Highway Bridges for Heavy Motor Truck Traffic. Eng. & Contracting, vol. 54, no. 17, Oct. 27, 1920, pp. 412–414. Progress report of Committee of American Road Builders' Association.

BRIDGES, LIFT

Bascule. A New Type of Bascule Span in the Highway Bridge over the Eider River Near Friedrichstadt (Neuartige Klappbrücke in der Strassenbrücke über die Eider bei Friedrichstadt). Zentralblatt der Bauverwaltung, vol. 40, no. 61, July 31, 1920, pp. 386–387, 6 figs. Describes an electrically driven, two-leaf bascule span with fixed axis of rotation. Points out advantages of two-leaf over single-leaf bridges.

BRIDGES, MOVABLE

Electric Operation. Electric Operation of Movable Bridges (La manoêvre électromécanique des ponts mobiles), Joseph Chanteux. Annales des Travaux publics de Belgique, vol. 21, no. 4, Aug. 1920, pp. 515–594, 45 figs. on 15 supp. plates. General theory. Design formulæ. Three types are considered: Lift bridges; turning bridges; and bascule bridges. (To be continued.)

[See also BRIDGES, LIFT.]

BRIDGES, RAILWAY

Poland, Official Regulations. Official Regulations for the Construction of Railway Bridges in Poland (La réglementation officielle des ponts-routes en Pologne), Maximilien Thublie. Génie Civil, vol. 77, no. 15, Oct. 9, 1920, pp. 293–295, 9 figs. Classification of bridges. Elastic limits permissible.

Reconstruction Heavy Spans to be Rolled and Jacked in Difficult Bridge Reconstruction. Eng. News-Rec., vol. 85, no. 19, Nov. 4, 1920, pp. 904–907, 3 figs. New double-track structure of increased load capacity provides wider channel openings and greater clearance height. Erection under traffic. Will shift track to higher elevation in one day.

Specifications. New Steel Railway Bridge Specification. Can. Engr., vol. 39, no. 17, Oct. 21, 1920, pp. 443–445. Canadian Engineering Standards Association issues specification for bridges not exceeding 500-ft. span based on draft prepared by Engineering Institute. Cooper's loadings and American Railway Engineering Association's impact formula adopted. Secondary stress computation optional. Parabolic column formula. Movable bridges.

BRIDGES, WOODEN

Poland. Construction of the Bridge over the Dubiss

ENGINEERING INDEX (Continued)

River Near Lidowiany (Der Bau der Brücke über die Dubissa bei Lidoviani). Eisenbau, vol. 11, no. 15, Aug. 10, 1920, pp. 255–271, 28 figs. Describes construction during the war by MAN Works Gustavsburg, of wooden bridge, about 700 m. long and 40 m. high, having nine openings spanned by superstructures of 62.40 m. each, in the form of parallel trussed girders with diagonals rising and falling alternately.

BRONZES

Manganese. Note on a Failure of "Manganese Bronze," J. H. S. Dickenson. Eng., vol. 110, no. 2860, Oct. 22, 1920, pp. 556–558, 15 figs. Experimental study of conditions under which alloys of manganese-bronze type are prejudicially affected by contact with fluid solder and effect of variation in composition and microstructure. Paper read before Inst. of Metals.

BUILDING CONSTRUCTION

See WALLS.

C

CARBON BLACK

Manufacture. The Disk, Plate and Cylinder Processes for the Production of Carbon Black, Roy O. Neal. Chem. & Metallurgical Eng., vol. 23, no. 16, Oct. 20, 1920, pp. 785–789, 8 figs. Description with mechanical details of disk, plate and cylinder process carbon black plants. Driving mechanism and heat variations. Comparison of processes.

CARBURETORS

Fuel-Feeding Devices. The N. K. F. Vacuum Fuel Feeder (Der N. K. F.-Unterdruck-Brennstofförderer), Wa. Ostwald. Allgemeine Automobil-Zeitung, vol. 21, no. 28, July 10, 1920, pp. 26–27, 1 fig. Describes fuel-feeding device which is said to have the advantage that the carburetor is always provided with fuel at starting of motor and is never without fuel when climbing a hill. The two chambers are constructed, not one above the other, but one within the other.

Various Construction Types of Vacuum Fuel Feeding Devices (Verschiedene Bauarten bei der Unterdruck-Förderung des Brennstoffs), H. v. Löw. Allgemeine Automobil-Zeitung, vol. 21, no. 26, June 26, 1920, pp. 29–30, 7 figs. Describes working method of such apparatus.

CARS

Buffers. A Self-Contained Railway Buffer with Non-Breakable Shank. Ry. Gaz., vol. 33, no. 17, Oct. 22, 1920, p. 550, 2 figs. Railway buffer fitted with George Spencer Moulton & Co.'s patent rubber spring.

Tipping. Railway Loading and Off-Loading Arrangements, H. Aumund. Eng. Progress, vol. 1, no. 10, Oct. 1920, pp. 309–313, 13 figs. Problems of rail transport. Railway tipping cars and their various designs. Arrangement, construction, application, and capacity of new portable tipping device. Comparison with automatic tipping arrangements.

Weighing Machines. A New Railway Wagon Weighing Machine, T. J. Primrose. Ry. Engr., vol. 41, no. 490, Nov. 1920, pp. 454–455, 5 figs. Apparatus for measuring load on locomotive and car wheels with object of finding pressure with which wheels bear upon rails.

CARS, PASSENGER

Pullman Improvements. Improvements in New Pullman Sleepers. Ry. Age, vol. 69, no. 16, Oct. 15, 1920, pp. 661–664, 9 figs. Changes in details which have been developed to add to comfort and safety of travel.

CAST IRON

Nickel and Cobalt, Effect of. The Influence of Nickel and Cobalt Additions on the Physical and Chemical Properties of Cast Iron (Der Einfluss eines Nickel- und Kobaltzusatzes auf die physikalischen und chemischen Eigenschaften des Gusseisens), O. Bauer and E. Piwowarsky. Stahl u. Eisen, vol. 40, no. 39, Sept. 30, 1920, pp. 1300–1302, 3 figs. Results of investigations are given in tabular form, from which it is concluded that for production of high-grade castings for machine parts, gear wheels, etc., a nickel addition up to 1.2 per cent can be thoroughly recommended, but an addition of cobalt for the refining of cast iron is not feasible. Report from Metallurgical Inst. of Technical Academy of Breslau.

CEMENT GUN

Fireproofing with. Tests Show that Buildings May Be Rendered Fireproof with Gunite, B. C. Collier. Coal Age, vol. 18, no. 19, Nov. 4, 1920, pp. 939–942, 3 figs. Tests made by Anaconda Copper Mining Co. and at Underwriters Laboratory in Chicago.

CENTRAL STATIONS

Cuba. Central-Station Operation in Tropical America, L. E. Gowling. Power, vol. 52, no. 16, Oct. 19, 1920, pp. 606–609, 5 figs. Central station in Havana, Cuba. Plant supplies current for operation of electric railway and electric light and power service for city of Havana.

Electrical Equipment. The Electrical Equipment of the Golpa Central Station (Die elektrischen Einrichtungen des Kraftwerkes Golpa), Heinrich Probst. Elektrotechnische Zeitschrift, vol. 41, nos. 34 and 35, Aug. 26 and Sept. 2, 1920, pp. 665–667 and 687–690, 11 figs. Extract from treatise by Klingenberg on construction of large electrical plants (published by J. Springer) dealing principally with the electrical equipment of the Golpa plant. Notes on arrangement of switch plant, long-distance line, etc.

Middle West. Power Service for a Middle West Section, Lyle A. Whitsit. Elec. World, vol. 76, no. 20, Nov. 13, 1920, pp. 969–971, 2 figs. Survey in Western Pennsylvania and Eastern Ohio by power section of War Industries Board indicates aggregate power peak demand during 1918 of 568,000 kw. and total central-station output in this district of 2,440,000,000 kw-hr. Estimated increased peak load of 1,000,000 kw. by 1927.

CHEMICAL INDUSTRY

Sweden. Chemical Industry and Trade of Sweden, O. P. Hopkins. Jl. Indus. & Eng. Chem., vol. 12, no. 11, Nov. 1920, pp. 1045–1054. Statistics showing strengthening of industries since 1914.

CHROME-NICKEL STEEL

See ALLOY STEELS, Non-Expanding.

COAL

Conservation. George Otis Smith on Thrift in Coal. Iron Age, vol. 106, no. 18, Oct. 28, 1920, pp. 1122–1124, 3 figs. Suggestions for economical use of coal in steel industry and by railroads. Paper read before Am. Iron & Steel Inst.

Thrift in Coal, George Otis Smith. Power, vol. 52, no. 18, Nov. 2, 1920, pp. 716–718, 3 figs. Suggestions in regard to coal combustion. Paper read before Am. Iron and Steel Inst.

Distillation of. The Low-Temperature Distillation of Coal in a Revolving Kiln (Die Tieftemperaturentgasung der Kohle im Drehofen), H. Gwosdz Zeit. für Dampfkessel u. Maschinenbetrieb, vol. 43, no. 35, Aug. 27, 1920, pp. 265–267, 1 fig. Account of distillation tests in a large revolving kiln, 24 m. long and 2¹/₂ m. in diameter, into one end of which the fuel is fed while from the other end the semi-coke is carried out. Favorable results were obtained.

Mixtures. Graphic Method of Determining Proportions of Coal Mixtures, Edward J. Clarke. Power Plant Eng., vol. 24, no. 22, Nov. 15, 1920, p. 1066, 1 fig. Chart for determining proportions of coal mixtures.

Oil vs. Coal Versus Oil Performance Chart, L. C. Lichty. Indus. Management, vol. 60, no. 5, Nov. 1920, pp. 351–352, 5 figs. Calculations are based on cost per ton of coal delivered at plant, its heating value and efficiency of boiler plant when burning coal, in comparison with results determined by making use of density of oil fuel, heating value per barrel, cost per barrel delivered and efficiency when burning fuel.

Supply. The Problems of Coal Supply, Eugene McAuliffe. Elec. Ry. Jl., vol. 56, no. 16, Oct. 16, 1920, pp. 754–759, 5 figs. It is said that storage at point of consumption will improve "load factor" of fuel production and distribution. It is believed that national legislation providing for seasonal variation in coal-haulage rates would encourage uniformity of demand for coal and reduce mining costs. (Abstract.) Paper read before Am. Elec. Ry. Assn.

COAL BREAKERS

Dry Treatment. Preparing Anthracite for Market Without the Use of Water, Dever C. Ashmead. Coal Age, vol. 18, no. 19, Nov. 4, 1920, pp. 935–938, 8 figs. It is claimed that mechanical equipment and dust suckers render dry treatment almost as free from dust as wet preparation.

COAL GAS

Detarring. The Detarring of Gas by Electrical Precipitation, J. G. Davidson. Dominion of Canada, report no. 3, 1918, 45 pp., 4 figs. Report of experimental work. Successful tests of process of electrical precipitation for detarring of gas on commercial scale were made in wood, coal and petroleum distillation plants.

COAL MINES

Bituminous, Gas Explosion Prevention. Rules for Prevention of Gas Explosions, R. A. Walter. Coal Age, vol. 18, no. 19, Nov. 4, 1920, pp. 945–947. Rules based on writer's experience gained in bituminous coal mines as mine owner and manager for many years. Paper read before Ninth Annual Safety Congress.

COAL MINING

Difficulties Overcome. By New Operating Methods Estimated Life of Seneca Colliery has been Tripled, Dever C. Ashmead. Coal Age, vol. 18, no. 17, Oct. 21, 1920, pp. 839–845, 8 figs. Many difficulties, such as subterranean outcrops in glacial drift, mining under river beds, large inflow of water and one bed squeezed over practically entire area, have been encountered and surmounted in operating this mine.

COAL STORAGE

Fire Hazard. A Few of the Less Emphasized Causes Why Fine Sizes Ignite Soft-Coal Piles, O. P. Hood. Coal Age, vol. 18, no. 17, Oct. 21, 1920, pp. 845–848, 8 figs. One ton of coal in solid exposes 47 sq. ft. of surface to air. Crushed so as to pass sixteen-mesh sieve it exposes about one acre of surface. Extent and freshness of surface exposed and rapidity of ventilation are chief factors governing spontaneous heating. (Abstract.) Address delivered before Pennsylvania Elec. Assn.

Fire Prevention. The Storage of Coal, W. D. Langtry. Power, vol. 52, no. 18, Nov. 2, 1920, pp. 693–694, 6 figs. Relation method of piling coal bears to number of fires. Data are given which show that hand shoveling reduces fire hazard.

COKE

Advantages as Fuel. Coke in Relation to Cheap Power, Transport and Smoke Abatement, E. W. L. Nicol. A Thousand and One Uses for Gas (Supp.), vol. 8, no. 81a, pp. 4–20, 20 figs. Advantages of coke as fuel. Performance record of coke-fired boilers.

Hydrogen as Desulphurizing Agent. The Desulfurizing Action of Hydrogen on Coke, Alfred R. Powell. Jl. Indus. & Eng. Chem., vol. 12, no. 11, Nov. 1920, pp. 1077–1081, 1 fig. Curves showing elimination of sulphur as hydrogen sulphide from coal when coked under different conditions.

COKE MANUFACTURE

Reactions in. A Study of the Reactions of Coal Sulfur in the Coking Process, Alfred R. Powell. Jl. Indus. & Eng. Chem., vol. 12, no. 11, Nov. 1920, pp. 1069–1077, 3 figs. Experimental studies at Bureau of Mines.

COKE OVENS

Rotating. Low-Temperature Distillation of Coal in Rotating Coke Oven, Ing. E. Roser. Power, vol. 52, no. 17, Oct. 26, 1920, pp. 678–679, 1 fig. Low-temperature tar is reported to yield 90 per cent bitumens in coal as against 50 per cent under present methods. Translated from Stahl und Eisen.

COLLOIDS

Colloid Mill. Colloidal Chemistry and a "Colloid Mill." Eng., vol. 110, no. 2857, Oct. 1, 1920, pp. 429–430. New Type of fine grinding disintegrator or "colloid" mill claimed to be ideal apparatus for extremely fine grinding required for homogenizing and dissolving substances and for obtaining emulsions and colloidal preparations. Translated from Chemiker-Zeitung.

COMBUSTION

Initial Gas Temperature. The Importance of the Initial Gas Temperature and Scientific Stoking (Die Bedeutung der Anfangstemperatur und die feurungstechnische Kritik), J. Hudler. Zeitschrift des Vereines deutscher Ingenieure, vol. 64, no. 40, Oct. 2, 1920, pp. 810–814, 2 figs. It is shown that for maintenance of a certain hour-output of a given boiler furnace plant, every increase of initial temperature causes a decrease of temperature of gases on leaving flue, which is brought about by reducing rate of combustion; increase of initial temperature also signifies reduction of chimney losses in temperature and volume of flue gases. The true ratio of value of different fuels, such as peat and peat dust, to anthracite is calculated.

COMPASSES

Gyroscopic. Principles of the Gyro-Compass, George B. Crouse. Mech. Eng., vol. 42, no. 11, Nov. 1920, pp. 619–623, 16 figs. Problems of design, special compensation of disturbing factors, methods of suspension and methods of damping.

COMPRESSED AIR

Pneumatic Mail Despatch. Pneumatic Mail Despatch in the Municipality of Berlin, Postbaurat Kasten. Eng. Progress, vol. 1, no. 10, Oct. 1920, pp. 305–308, 5 figs. Alternating air-current service with double-tube line, each tube for one direction only. Connection between old and new central telegraph office in Berlin. Equipment and switch connections. Graphic reproduction of pressure in tube.

CONCRETE

Pavement Slabs. Study of Temperature Stresses in Rigid Pavement Slabs, C. H. Scholer. Eng. News-Rec., vol. 85, no. 20, Nov. 11, 1920, pp. 943–944, 3 figs. Research at Engineering Experiment Station of Kansas State Agricultural College.

CONCRETE CONSTRUCTION

Marine Structures. The Durability of Maritime Structures. Nature (London), vol. 106, no. 2660, Oct. 21, 1920, pp. 235–236. Report of Committee of Instn. of Civil Engrs., appointed to investigate deterioration of structures of timber, metal and concrete exposed to action of sea water.

CONCRETE CONSTRUCTION, REINFORCED

Coal Mines. Ferro-Concrete Pit-Head Frame at Bently Colliery, Doncaster. Eng., vol. 110, no. 2859, Oct. 15, 1920, pp. 498–501, 71 figs. partly on supp. plate. Main building is about 132 ft. long by 32 ft. wide, with height, from foundations to roof of 64 ft.

Supports. Determination of Stress in Reinforced-Concrete Supporting Parts of any Given Cross-Section with Inclined Loading (Spannungsermittlung bei Eisenbetontragteilen beliebigen Querschnitts mit schrägem Lastangriff), G. Hartschen. Beton u. Eisen, vol. 19, no. 14, Sept. 4, 1920, pp. 167–169, 3 figs. Supplementary to author's article in no. 17–18, 1918, of same journal. Formulæ are derived for determination of main tensions for reinforced-concrete supports with inclined load, under two conditions, namely, when position of main axis of cross-section is known and when it is unknown.

CONCRETE, REINFORCED

Flat-Slab. Diagram for Flat Slab Design, O. Wolpert. Eng. & Contracting, vol. 54, no. 17, Oct. 27, 1920, p. 411, 1 fig. Diagram for estimating amount of reinforcing steel and thickness of slab required by New York City 1920 regulations.

ENGINEERING INDEX (Continued)

Liquid Mixtures. Liquid Concrete Mixtures for Reinforced-Concrete (Flüssige Betongemische für Eisenbeton), H. Amos. Beton u. Eisen, vol. 19, no. 14, Sept. 4, 1920, pp. 164–167. Discussion of report on experiments in Royal Material-Testing Station, Berlin-Lichterfelde by Director M. Gary, from which following conclusions are drawn: Iron molds, heretofore commonly used, are not feasible for liquid concrete mass; wooden molds exhibit uncertainties in test; plaster molds produce samples whose strength is almost equal to that of concrete.

CONDENSERS, ELECTRIC

Electrostatic. Electrostatic Condensers, V. E. Goodwin. Jl. Am. Inst. Elec. Engrs., vol. 39, no. 11, Nov. 1920, pp. 976–983, 13 figs. Fundamental characteristics of condensers and their relation to electric circuits containing inductance and resistance. Effects of switching condensers on and off such circuits. Applications of condensers.

CONDUITS

Concrete. Casting and Steaming Reinforced Pipe. Public Works, vol. 49, no. 16, Oct. 16, 1920, pp. 358–360, 6 figs. Fabricating and seasoning in contractor's yard ten miles of reinforced concrete pipe 5 1/2 ft. in diameter and 8 in. thick.

Reinforced-Concrete Pressure Pipes in Hydroelectric Plants (Druckrohre aus Eisenbeton bei Wasserkraftanlagen), Leo Nagel. Beton u. Eisen, vol. 19, no. 14, Sept. 4, 1920, pp. 153–155, 6 figs. Description of 1.4-km. pipe line in hydraulic plant of the Perlmooser Corp., Kirchbichl-Tirol, with diameter of 2.20 m. and pressure of 2 atmos., demonstrating economic advantages of use of reinforced-concrete pressure pipes.

CONNECTING RODS

Machining. Machining the Connecting Rods of Two Well Known Motors, Fred H. Colvin. Am. Mach., vol. 53, no. 19, Nov. 4, 1920, pp. 829–834, 20 figs. Method of manufacturing connecting rods for Oakland and Studebaker motors.

CONTRACTS

Cost Plus. Dam Contract Has Special Cost-Plus Feature. Eng. News-Rec., vol. 85, no. 19, Nov. 4, 1920, pp. 878–879. Provision made for sliding scale of payments depending on actual cost of Wanaque water supply project in New Jersey.

CONVEYORS

Marcus Trough. The Use of the Marcus Conveying Trough in Foundries and Other Plants (Ueber die Anwendung der Marcus-Rinne in Giessereien und anderen Betrieben), Wilhelm Venator. Der praktische Maschinen-Konstrukteur, vol. 53, no. 29–30, July 22, 1920, pp. 257–264, 24 figs. Consists of a rigid sheet-iron trough resting on rollers with a uniform acceleration forward and a corresponding retardation on return path. Describes its many useful possibilities and points out that its cost is low in comparison to its practicability and advantages.

CORROSION

Galvanized Iron. Destruction of Galvanized Corrugated Iron through Flue Gases (Zerstörung von verzinktem Eisenwellblech durch Rauchgase), Ph. Siedler. Rauch u. Staub, vol. 10, no. 9–10, June-July, 1920, pp. 43–50, 18 figs. on 6 supp. plates. Based on investigations and literature, it is concluded that the resistivity of galvanized corrugated iron, when used for structures exposed to flue gases containing SO_2 or to flue-dust deposits, is of short duration, and when its employment for this purpose is unavoidable, it is advisable to add a protective coating against rust. Bibliography.

Iron. Corrosion of Iron in Sulphuric Acid. Effect of Chromium Compounds, George W. Heise and Amando Clemente. Philippine Jl. of Sci., vol. 16, no. 5, May 1920, pp. 439–446, 1 fig. Experiments conducted to determine effect of (1) varying concentration of sulphuric acid and of potassium dichromate, and (2) of additions of chromium salts.

Steel. Studies on the Corrosive Action of Chlorine-Treated Water. I—The Effects of Steel on the Equilibrium: $Cl_2 + H_2O \rightleftharpoons HCl + HClO$, and of Products of the Equilibrium of Steel, George L. Clark and R. B. Iseley. Jl. Indus. & Eng. Chem., vol. 12, no. 11, Nov. 1920, pp. 1116–1122. Based on records of corrosion produced by water of various American cities.

Theories of. The Effect of Air and Water on Materials Used in Engineering Work, H. E. Yerbury. Jl. Instn. Elec. Engrs. (Supp.), vol. 57, part 2, Oct. 1920, pp. 118–126 and (discussion) pp. 126–133. Chemical and electrolytic theories of corrosion. Effects on iron and steel and non-ferrous alloys. Instances of damage to metals, etc., subjected to air and water.

COST ACCOUNTING

Machine Shops. Machine Rate Hour in Distributing Expense, Christopher Haigh. Iron Age, vol. 106, no. 19, Nov. 4, 1920, pp. 1207–1208. General advantages of method. (Abstract.) Paper read before Am. Gear Manufacturers' Assn.

Predetermining Needs. When, What and How Much to Buy, Charles W. Dean. Indus. Management, vol. 60, no. 5, Nov. 1920, pp. 362–364, 5 figs. Predetermining raw material needs as function of cost accounting.

CRANES

Electric. 25-Ton Electric Luffing Crane. Eng., vol. 110, no. 2859, Oct. 15, 1920, pp. 501–503, 5 figs. Electric crane fitted with Toplis horizontal luffing gear and balanced jib supplied to Port of London Authority by Stothert & Pitt, Ltd., England.

60-Ton Electric Overhead Traveling Forge Crane. Eng., vol. 110, no. 2861, Oct. 29, 1920, pp. 572–574 and p. 576, 6 figs. Constructed by William Arrol & Co., Ltd., Glasgow. Crane has span of 56 ft. 11 in. and height from floor to rail level of 28 ft. 9 in. With load of 60 tons hoisting motor of 50 b.hp. running at 470 r.p.m. gives lift of 8 ft. per minute.

Floating. Two Hundred-Ton Floating Crane for Liverpool. Engr., vol. 130, no. 3381, Oct. 15, 1920, pp. 375 and 378, 3 figs. Crane lifts weight of 200 tons and hoists up to height of 170 ft. above water line at distance of 110 ft.

Safety Devices. Crane Safety Devices, Nicholas Prakken. Metal Trades, vol. 2, no. 11, Nov. 1920, pp. 453–455, 5 figs. Typical safety devices for cranes used in foundries, machine shops, yards, shipyards and warehouses. Paper read before Nat. Safety Congress.

CRANKSHAFTS

Torsional Vibration. The Critical Speeds of Torsional Vibration, F. M. Lewis. Jl. Soc. Automotive Engrs., vol. 7, no. 5, Nov. 1920, pp. 418–424 and (discussion) pp. 424–431, 14 figs. Mathematical study.

Torsional Vibration and Critical Speeds in Crankshafts, J. F. Fox. Jl. Soc. Automotive Engrs., vol. 7, no. 5, Nov. 1920, pp. 413–417 and p. 435, 14 figs. Vibration chambers constructed to overcome torsional vibration in crankshaft of submarine engine.

CUPOLAS

Slag from. Operating Analysis of Cupola Furnace Slag (Betriebsanalyse der Kupolofenschlacke), Bernhard Osann. Giesserei Zeitung, vol. 17, no. 17, Sept. 1, 1920, pp. 275–276. Notes on the rapid determination of CaO, Mn, Fe, and S contents.

CUTTING METALS

Drilling. Supplement to Frederick W. Taylor's "On the Art of Cutting Metals"—XII, Carl G. Barth. Indus. Management, vol. 60, no. 5, Nov. 1920, pp. 365–372, 14 figs. Writer shows how intelligent study of drill shapes, speeds and feeds may be made to contribute to tool endurance and increased production.

[See also OXY-ACETYLENE CUTTING.]

CYANAMID PROCESS

Action of CO on. Studies on Calcium Cyanamide, Naoto Kameyama. Jl. College of Eng., Tokyo Imperial University, vol. 10, no. 9, Aug. 25, 1920, pp. 309–347, 7 figs. Action of carbon monoxide upon calcium cyanamide.

Heat of Formation. Heat of Combustion and Heat of Formation of Calcium Cyanamide, Naoto Kameyama. Jl. College of Eng., Tokyo Imperial University, vol. 10, no. 10, Aug. 30, 1920, pp. 239–253. Experimental determination.

Preparation. On the Preparation of Cyanamide of Calcium, Naoto Kameyama. Jl. College of Eng., Tokyo Imperial University, vol. 10, no. 8, July 25, 1920, pp. 173–207. Experimental study of chemical reactions, taking urea and dicyandiamide as amides.

CYLINDERS

Cores. Cylinder Cores Made in Green Sand. Foundry, vol. 48, no. 21, Nov. 1, 1920, pp. 861–866, 12 figs. Special machines for cores and molds together with accurately fitting flasks and arbors are outstanding features of process.

D

DAMS

Concrete, Gravity. Construction Features of Snow Mountain Dam. Elec. Rev. (Chicago), vol. 77, no. 19, Nov. 6, 1920, pp. 725–726, 1 fig. Methods used in building gravity concrete dam for impounding storage water for Eel River Hydroelectric Plant of the Snow Mountain Water & Power Co. in California.

Spillways. Spillways for Weir Dams, with Special Consideration of Weir Dams on Alluvial Subsoil (Vor- und Sturzbetten an Stauanlagen mit besonderer Berücksichtigung der Wehranlagen auf angeschwemmtem Untergrunde), G. W. Schmidt. Zeitschrift für Bauwesen, vol. 70, no. 7–9, 1920, pp. 555–595, 29 figs. Gives rules for planning designs of spillways and similar constructions, and new recommendations.

Tilting. Tilting Dams Applied to Water Works Reservoirs, J. F. Springer. Fire & Water Eng. vol. 68, no. 18, Nov. 3, 1920, pp. 915–917, 5 figs. Description of Baltimore elastic dam with sections that tilt as backwater pressure approaches danger point. Sections open automatically at head at which they are set.

DIES

Embossing. Steelstamps. Embossing Dies. Stencils, Ellworth Sheldon. Am. Mach., vol. 53, no. 18, Oct. 28, 1920, pp. 789–794, 2 figs. Description of processes.

DIESEL ENGINES

Cement Mills. Diesel Engines in Cement Mills. Power, vol. 52, no. 17, Oct. 26, 1920, pp. 655–659, 3 figs. Installation at Iola, Kansas, of Lehigh Portland Cement Co. Engines have proven economical.

Compressorless. Diesel Engines Without Compressors (Ueber kompressorlose Dieselmaschinen), Arthur Balog. Der praktische Maschinen-Konstrukteur, vol. 53, no. 31, Aug. 5, 1920, pp. 282–284, 5 figs. It is claimed that Diesel engines can only become perfect when the spraying compressor is eliminated; an auxiliary compressor should suffice for starting; spraying can be effected with or without aid of spraying medium.

Experiments. British Admiralty Experiments with Diesel Engines—II, C. J. Hawkes. Motorship, vol. 5, no. 11, Nov. 1920, pp. 998–1001, 3 figs. Four-stroke vs. 2-stroke opposed-piston types. (Continuation of serial.)

Fuels for. Fuel for Diesel Engines, C. H. Peabody. Marine Eng., vol. 25, no. 11, Nov. 1920, pp. 915–917. Characteristics of various fuels.

Marine. New Double-Acting, Two-Cycle Marine Diesel-Engine, M. Goldberg. Motorship, vol. 5, no. 11, Nov. 1920, pp. 993–994, 4 figs. American engine of two-cycle double-acting type. Scavenging-air pump between working cylinders.

The Present Position of the Marine Diesel Engines, James Richardson. Eng., vol. 110, no. 2861, Oct. 29, 1920, pp. 589–592, 2 figs. Comparative economy of Diesel engines and steam engines for shipbuilders. Paper read before Instn. Engrs. & Shipbuilding in Scotland.

DRILLING

Rock, Dust Produced. Investigations Made with the Konimeter to Ascertain the Amount of Dust Produced in Drilling Holes by Means of Dry Jack Hammer Machines, H. E. Barrett. Jl. Chem., Metallurgical & Min. Soc. of South Africa, vol. 21, no. 1, July 1920, pp. 1–8.

Rock, Sticking of Steel. Stuck Steel, D. E. Dunn. Eng. & Min. Jl., vol. 110, no. 19, Nov. 6, 1920, pp. 903–905, 8 figs. Reasons for sticking of drill steel.

[See also CUTTING METALS, Drilling.]

DRILLING MACHINES

High-Speed Radial. The New Asquith High-Speed Radial. Machy. (Lond.), vol. 17, no. 419, Oct. 7, 1920, pp. 28–29, 1 fig. Radial drilling machines produced to meet demands for medium-sized high-speed machine to deal with holes of moderate size in work.

DRY KILNS

Superheated Steam. Drying Lumber with Superheated Steam. Forest Products Laboratory, Technical Notes, Oct. 15, 1920, no. 111, 1 p. Superheated steam process has been found applicable to Douglas fir, firs of all kinds, western hemlock, white cedars, sugar pine, western yellow pine and southern yellow pine. Process is unsuited for some softwoods on account of collapse.

Water Spray. Manual for Design and Installation of Forest Service Water Spray Dry Kiln, L. V. Teesdale. U. S. Dept. Agriculture, bul. no. 894, Oct. 18, 1920, 47 pp., 18 figs.

E

ELECTRIC CIRCUITS, A. C.

Current Distribution. A Device for the Rapid Determination of the Current Distribution on the Line Side of a Three-Phase Interconnected-Star Static Balancer Operating on a Four-Wire System, S. Austen Stigant. Jl. Instn. Elec. Engrs. (Supp.), vol. 57, part 2, Oct. 1920, pp. 201–208, 5 figs. Device for determining line currents under different loading conditions.

ELECTRIC FURNACES

Booth Rotating. Booth Rotating Electric Furnace, Carl H. Booth. Metal Industry (N.Y.), vol. 18, no. 10, Oct. 1920, pp. 456–459, 3 figs. Description of furnace. Records of operation as obtained in installations ranging in size from 250 lb. to 2000 lb. per heat.

Greaves-Etchells. An Improved Greaves-Etchells Electric Furnace Installation, Edward T. Moore. Chem. and Metallurgical Eng., vol. 23, no. 17, Oct. 27, 1920, pp. 825–832, 21 figs. Description of Greaves-Etchells electric furnace and of arrangement of electrical equipment as installed at plant of Halcomb Steel Co. Records of operation.

Metal-Melting. Application of Electrical Energy to the Melting of Metals, H. A. Greaves. Jl. Instn. Elec. Engrs. (Supp.), vol. 57, part 2, Oct. 1920, pp. 250–253 and (discussion) pp. 276–305, 11 figs. Comparative study of different types of furnaces.

Operating Data. Electric Furnace Operating Data, C. H. Reeder. Eng. World, vol. 17, no. 5, Nov. 1920, pp. 352–355, 4 figs. Present and future prospects of electric furnaces. Figures showing various items of expense involved in melting of steel. Unit costs. Raw materials and finished product.

Refractories for. Electric Furnace Refractories, A. F. Greaves-Walker. Chem. & Metallurgical Eng., vol. 23, no. 19, Nov. 10, 1920, pp. 933–936. Description of raw materials available for highest-grade brick with list showing recommended refractories for melting different metals and alloys, and hints on care, storage and laying of roofs, hearths and linings.

Sahlin. A New Type of Electric Furnace, Axel Sahlin. Jl. Instn. Elec. Engrs. (Supp.), vol. 57, part 2, Oct. 1920, pp. 265–267, 2 figs. Sahlin

ENGINEERING INDEX (Continued)

furnace designed with a view to embodying advantages of both direct arc and free-burning arc furnaces.

Steel Refining. Developments in Electric Iron and Steel Furnaces, J. Bibby. Jl. Instn. Elec. Engrs. (Supp.), vol. 57, part 2, Oct. 1920, pp. 231-246, 24 figs. Electric reduction furnace and steel refining furnace are taken up.

Large Electric Steel-Melting Furnaces, Victor Stobie. Jl. Instn. Elec. Engrs. (Supp.), vol. 57, part 2, Oct. 1920, pp. 268-276, 9 figs. Furnace requirements of a large steel plant.

United Kingdom. Electric Furnaces in the United Kingdom, 1918, R. G. Mercer. Jl. Instn. Elec. Engrs. (Supp.), vol. 57, part 2, Oct. 1920, pp. 254-264. Records of operation of electric furnaces used in manufacture of steel.

ELECTRIC GENERATORS, A. C.

Slow Speed. 1,750 K. V. A. Slow-Speed Alternator. Eng., vol. 110, no. 2857, Oct. 1, 1920, pp. 440-442 and 444, 22 figs. Constructed by General Electric Co., Ltd., Engineers, London. Terminal pressure in tests was 5200 volts between phases and frequency 50 cycles per second at speed of 187.5 r.p.m.

ELECTRIC GENERATORS, D. C.

Axle. Specification for Axle Generators. Ry. Elec. Engr., vol. 11, no. 10, Oct. 1920 pp. 367-370. Specification intended to cover axle-generator equipment for railway service. Committee report of Assn. of Elec. Engrs.

ELECTRIC LAMPS, ARC

Cooper Hewitt. The Cooper Hewitt Lamp—II, L. J. Buttolph. Gen. Elec. Rev., vol. 23, no. 10, Oct. 1920, pp. 858-866, 17 figs. Outlines development and some applications of lamp from 1901 to present time.

ELECTRIC LOCOMOTIVES

Crank Gear, Critical Speeds of. The Critical Speeds of Crank Gears of Electric Locomotives (Die kritischen Drehzahlen der Kurbelgetriebe elektrischer Lokomotiven), W. Kummer. Schweiz. elektrotechnischer Verein Bull., vol. 11, no. 9, Sept. 1920, pp. 237-242, 3 figs. Gives critical numbers of revolutions which can be expected in the case of so-called ideal crank gear; crank gear with deviation of rod lengths from distance of bearing center; and crank gear with play of bearings. It is pointed out that in the construction of large locomotives with parallel crank gears, the occurrence and prevention of critical speeds should be investigated by means of preliminary calculations.

Heavy Electric Traction. Report of the Committee on Heavy Electric Traction. Am. Elec. Ry. Eng. Assn., report no. 305, Oct. 11-15, 1920, 24 pp., 20 figs. Survey of recent developments and progress in design of motors and motor drives for heavy traction, both a.c. and d.c., with comparison of weight, space efficiency, etc.; description and illustrations of recent types of electric locomotives since report of 1916; and comparison of electric switching engines in freight yards with steam engines.

Italian State Railways. Three-Phase Electric Locomotive for the Italian State Railways. Eng., vol. 110, no. 2858, Oct. 8, 1920, pp. 469-471, 22 fig. partly on 4 supp. plates. Details of six three-phase 4-6-4 type electric locomotives built by Construzioni Meccaniche di Saronno of Milan. Working voltage is 3300. Maximum draw-bar pull is 26,000 lb.

Performance. Data on Electric Locomotive Performance. Elec. World, vol. 76, no. 18, Oct. 30, 1920, pp. 878-880, 1 fig. Advantages claimed for electric locomotive are economy of fuel, increased haulage, low maintenance and general flexibility. Graph showing coal consumption comparison on identical runs by steam and electric locomotives is included.

ELECTRIC METERS

Mean Intensity Indicator. Chromothermic Mean Intensity Indicator (Indicateur chromothermique d'intensité moyenne), Ch. Ed. O'Keenan. Revue générale de l'Electricité, vol. 8, no. 15, Oct. 9, 1920, pp. 493-497, 8 figs. A steel needle is heated by passage of current. Current intensity is determined from nature of coloration assumed by needle.

ELECTRIC MOTORS

Railway. The Ventilation of Railway Motors (Beitrag zur Lüftung von Bahnmotoren), W. Dittrich. Elektrische Kraftbetriebe u. Bahnen, vol. 18, no. 13, May 4, 1920, pp. 114-115, 1 fig. Describes air vane designed by author in which the air enters motor on the ventilator side and passes out on the commutator side, carrying off carbon dust which otherwise would settle on windings.

Standardization. Motor Features Requiring Standardization. C. W. Starker. Elec. World, vol. 76, no. 19, Nov. 6, 1920, pp. 919-921, 5 figs. Urges standardization of mechanical features of electrical motors.

ELECTRIC MOTORS, D. C.

Crane and Hoist Drive. Direct-Current Motors for Crane and Hoist Work, F. L. Moon. Elec. Jl., vol. 17, no. 11, Nov. 1920, pp. 532-535, 7 figs. Graphs showing comparative characteristics of enclosed and ventilated motors.

Reversing Pole. The Calculation of the Reversing Pole in Direct-Current Motors (Zur Berechnung der Wendepole bei Gleichstrommaschinen), Wilhelm Oelschläger. Elektrotechnik u. Maschinenbau, vol. 38, no. 23, June 6, 1920, pp. 261-266, 7 figs. Formulæ are derived for practical use in calculation of reversing-pole flux, based on existing commutation theories and on calculating methods of various authors.

Starters. New Motor Starter Embodies Many Interesting Features. Power Plant Eng., vol. 24, no. 22, Nov. 15, 1920, pp. 1075-1076, 2 figs. Automatic starter designed for general use in controlling series, shunt and compound-wound direct-current motors employed to drive pumps, line-shafts, compressors, blowers, conveyors, etc.

ELECTRIC PLANTS

Inspection. Scheduled Inspection for Power Plants. Elec. World, vol. 76, no. 19, Nov. 6, 1920, pp. 922-924, 2 figs. Forms for keeping records.

Interconnection. Interconnection of Power Systems, Harold W. Smith. Elec. Jl., vol. 17, no. 11, Nov. 1920, pp. 515-518, 4 figs. Comparative study of the various method of interconnecting generating stations.

Remote Control. Remote Control in Three-Phase Plants (Fernsteuerung in Drehstromanlagen), H. Roth. Elektrotechnische Zeitschrift, vol. 41, no. 35, Sept. 2, 1920, pp. 685-686, 6 figs. Describes system for three-phase plants which permits, without special switch lines, the selective connection or disconnection of a large number of switches, in which use is made of a split-up direct-current superposed on the three-phase current, making use of the resonance between this direct current and the natural vibration of a small direct-current armature serving as a receiver.

ELECTRIC RAILWAYS

Buildings and Structures. Report of the Committee on Buildings and Structures. Am. Elec. Ry. Eng. Assn., report no. 309, Oct. 11-15, 1920, 17 pp., 7 figs. Inspection and maintenance of buildings and structures; lag screws vs. bolts in timber-decked structures; prepayment and postpayment collection of fares at terminals; review of existing standards and recommendations.

Current Standardization. Problems of the Electric Railway, G. Wüthrich. Engr., vol. 130, no. 3377, Sept. 17, 1920, pp. 281-283, 1 fig. It is argued that extra high-tension low periodicity single-phase current system is alone capable of lending itself to immediate and simultaneous standardization for both suburban and main line traction.

Diesel-Electric Motor Cars. Diesel-Electric Motor Cars of the Swedish Railways (Automotrices pétroléo-électriques à moteur Diesel des chemins de fer suedois). Génie Civil, vol. 77, no. 16, Oct. 16, 1920, pp. 305-309, 16 figs. Used in local railways.

Equipment. Report of the Committee on Equipment. Am. Elec. Ry. Eng. Assn., report no. 311, Oct. 11-15, 1920, 39 pp., 33 figs. Standards for brakeshoes, brakeshoe heads, and brakeshoe keys; feasibility of adopting standard cars.

Power Distribution. Report of the Committee on Power Distribution. Am. Elec. Ry. Eng. Assn., report no. 304, Oct. 11-15, 1920, 100 pp., 7 figs. Specifications for overhead line material, electric light, power supply, trolley lines crossing steam and electric railroads, standard thread for pins and insulators, etc.

Power Generation. Report of the Committee on Power Generation. Am. Elec. Ry. Eng. Assn., report no. 308, Oct. 11-15, 1920, 60 pp., 5 figs. Recommended form of power contract for purchase of power; comparative cost of steam production for utilization in electric power plants from using coal, oil, gas or other special fuels; tabulation of costs of power generated by member companies.

Speed-Time Curves. Note on the Drawing of the Speed-Time Curves of Electric Trains, J. Musyck. Bul. Int. Ry. Assn., vol. 2, no. 9, Sept. 1920, pp. 581-590, 7 figs. Graphical method.

Trolley Contact Voltage. What Happens at the Trolley Contact? D. D. Ewing. Elec. Ry. Jl., vol. 56, no. 17, Oct. 23, 1920, pp. 863-865, 3 figs. Results of tests under various operating conditions. Contact voltage graphs for various types of wheels are shown. Average power loss with 5-in. wheel was nearly $^1/_3$ kw.

ELECTRIC RAILWAYS, TRACK

Circuiting. Alternating-Current Track Circuiting, L. H. Peter. Jl. Instn. Elec. Engrs., vol. 58, no. 292, June 1920, pp. 491-506, 30 figs. Distinction is made between "in phase" and "quadrature" relays, vector diagrams are given of track circuit without impedance bonds and phase displacement is obtained with two types of relays. Vector diagrams of track circuit with non-resonated and with resonated impedance bonds are also constructed. Method of varying the relay track-winding power factor is given and effect on vector diagram discussed.

Insulated Tools. Insulated Tools for Use on the Permanent Way of Electrified Railways. Ry. Gaz., vol. 33, no. 17, Oct. 22, 1920, pp. 541, 2 figs. Newly designed insulated tools, patented and manufactured by British Power Railway Signaling Co.

Track Welding. See ELECTRIC WELDING, Rails.

Trackwork Specifications. Report of the Committee on Way Matters. Am. Elec. Ry. Eng. Assn., report no. 310, Oct. 11-15, 1920, 95 pp., 13 figs. Recommended specifications for track spirals; standard sections for curved-head rails; revision of specifications for plain bolted special trackwork; specifications for wood-block paving; compilation of data on safe limits of wear in rails and special trackwork on life of track construction of various types.

ELECTRIC TRANSMISSION LINES

Characteristics. Electrical Characteristics of Transmission Circuits—XIII, Wm. Nesbit. Elec. Jl., vol. 17, no. 11, Nov. 1920, pp. 527-532, 3 figs. Comparative study of characteristics of various types.

High-Voltage. Notes on the Electrical Calculations of Long-Distance High-Voltage Transmission Lines, A. McKinstry. Jl. Instn. Elec. Engrs. (Supp.), vol. 57, part 2, Oct. 1920, pp. 92-117, 8 figs. Fundamental formulæ for transmission lines without branches. Study of constant voltage transmission.

Lightning Protection. See LIGHTNING ARRESTERS.

Long-Distance. Calculation, Diagrams and Regulation of Long Distance Electric Transmission Lines (Calculs, diagrammes et regulation des lignes de transport d'énergie à longue distance), L. Theilemans. Revue générale de l'Electricité, vol. 8, nos. 13, 14 and 15, Sept. 25 and Oct. 2 and 9, 1920, pp. 403-416, 435-443 and 475-482, 39 figs. Methods employed by writer in his practice as engineer of French Thomson-Houston Co. (To be continued.)

Switching and Protection. Switching and Protection of Transmission Circuits—III, S. Q. Hayes. Elec. Jl., vol. 17, no. 11, Nov. 1920, pp. 521-526, 7 figs. Exemplifies manner of proceeding by determining switching equipment needed in case of generating station containing fifteen 25,000-kva. vertical-shaft waterwheel generators.

Size of Wire. Determining Size of Wire and the Length of Span, D. F. Parrott. Elec. World, vol. 76, no. 19, Nov. 6, 1920, p. 928. No. 6 wire and 250-ft. span are said to be found economical for most cases where voltage lies between 33,000 and 66,000.

ELECTRIC WELDING

Methods. Electric Welding, Fred H. Williams. Jl. Eng. Inst. Canada, vol. 3, no. 11, Nov. 1920, pp. 514-522, 12 figs. History and survey of electric welding methods. Account of research work by writer.

Rails. Method of Preheating and Reheating of Workpieces in Electric Arc Welding or Autogenous Welding Work (Verfahren zum vor und nachwärmen von Werkstücken bei elektrischer Lichtbogenschweissung oder autogener Schweissung). Autogene Metallbearbeitung, vol. 13, no. 14, July 15, 1920, pp. 162-163. Details of process patented by the Accumulator Works Corp., Berlin, said to be of special value for the electric welding of rails.

ELECTRIC WELDING, ARC

Effect on Eye. Effect of Ultra-Violet Rays on the Eye, C. R. Kindall. Reports of Investigations, Bur. of Mines, Dept. of Interior, serial no. 2173, Oct. 1920, 2 pp. Records of effect on eye of electric arc welding.

ELECTRIC WELDING, RESISTANCE

Spot-Welding Machines. Modern Welding and Cutting—XXXI, Ethan Viall. Am. Mach., vol. 53, no. 18, Oct. 28, 1920, pp. 807-821, 39 figs. Spot-welding machines.

ELECTRICAL MACHINERY

Windings. The Maximum Temperature for Windings (Höchsttemperatur an Wicklungen), Kurt Lubowsky. Elektrotechnische Zeitschrift, vol. 41, no. 33, Aug. 19, 1920, pp. 646-647, 2 figs. The Vidmar formula for determination of maximum temperature from the mean and minimum temperature is tested on a long high-voltage stator coil, and results coincide with the observation of Rogowski and Vieweg on round coils according to which the minimum temperature should be measured directly on the conductors. It is concluded that the practicability of formula is limited.

ELECTRICAL SYMBOLS

International Standards. Electrical Symbols Proposed for International Adoption. Elec. World, vol. 76, no. 20, Nov. 13, 1920, pp. 971-972. Complete set adopted by Advisory Committee for consideration of next plenary meeting of international electrotechnical commission.

ELECTRICITY

World's Supply. Development of Rural Electricity Supply. Elecn., vol. 85, no. 2214, Oct. 22, 1920, pp. 472-475, 4 figs. Scheme of rural electricity supply in Hereford, England, a city of 22,000 inhabitants, which is center for commercial side of agricultural trade of surrounding district. Electricity is supplied to surrounding country from municipally owned station.

ELECTRON TUBES

Tungsten-Filament. Some Practical Operating Features of Tungsten Filament Electron Tubes, W. C. White. Gen. Elec. Rev., vol. 23, no. 10, Oct. 1920, pp. 840-846, 2 figs. Curves showing electron emission per watt of energy used to heat pliotron filament.

EMPLOYMENT MANAGEMENT

Bibliography. A Guide and Bibliography for Labor Managers, Leverett S. Lyon and May R. Freedman. Indus. Management, vol. 60, no. 5, Nov. 1920, pp. 383-385.

Interviewing Workers. The Art of Interviewing Workers, J. D. Hackett. Indus. Management, vol. 60, no. 5, Nov. 1920, pp. 338-340. Qualifications necessary in an interviewer, and essential steps in interviewing.

Vocational Classification of Employees. Making it Easy to Find the Right Technical Men, I. W.

ENGINEERING INDEX (Continued)

Litchfield. Factory, vol. 25, no. 8, Oct. 15, 1920, pp. 1232–1234, 2 figs. Suggests methods of classifying employees by industry and by function.

EMPLOYEES' REPRESENTATION

Shop Committees. The Operation of the Whitley Councils. Metal Industry (N. Y.), vol. 18, no. 10, Oct. 1920, p. 470. History, development and present state of England's experiment in coöperation between employer and employee. (Concluded.)

Workmen's Representation in a Tool Manufacturing Plant. Machy. (Lond.), vol. 17, no. 422, Oct. 28, 1920, pp. 111–115, 1 fig. Shop committee plan of Greenfield Tap & Die Corp. which operates six plants in U. S.

ENGINEERING SOCIETIES

The Federated American Engineering Societies. The Engineering Educator's Opportunity in Engineering Organization, William E. Bullock. Eng. Education, Bul. Soc. Promotion of Eng. Education, vol. 11, no. 2, Oct. 1920, pp. 72–75. Scheme of organization of engineering profession by means of Federated American Engineering Societies is explained. Plan of federation contemplates formation of all-inclusive local societies of engineers in important communities and their organization into federation for action on matters dealing with public service.

ENGINEERS

Fees and Salaries. Recommended Salaries for Manitoba Engineers. Contract Rec., vol. 34, no. 44, Nov. 3, 1920, pp. 1046–1047. Report on remuneration of engineers submitted by Salary Committee of Manitoba Branch of Engineering Institute of Canada.

Various Schedules of Fees for Consulting Engineers, Edmund I. Mitchell. Eng. News-Rec., vol. 85, no. 20, Nov. 11, 1920, pp. 941–942. Compiled by Edmund I. Mitchell, Assistant Secretary of Committee on Classification and Compensation of Engineers, Engineering Council, New York City, with aid of Engineering Societies' Library.

Registration. Report of Committee to the Minnesota Joint Engineering Board-Recommended Registration Law. Bul. Affiliated Eng. Soc. of Minnesota, vol. 5, no. 10, Oct. 1920, pp. 18–26. Suggested text of act to regulate practice of architecture, professional engineering and land surveying in Minnesota.

EXCAVATION, EARTH

See SHOVELS, Rotary.

EXCAVATORS

Development of. Recent Excavator Practice, F. H. Livens and W. Barnes. Jl. Instn. Mech. Engrs., no. 6, Oct. 1920, pp. 609–630 and (discussion) pp. 631–637, 16 figs. Survey of progress in development of types, with special reference to the steam-navvy.

Dragline. Storm Sewer Construction with a Dragline Excavator. Excavating Engr., vol. 14, no. 9, Nov. 1920, pp. 295–296. Description of excavation of large storm sewer in Detroit with dragline excavator. Method of handling forms.

EXPLOSIVES

Explosion Point, Determination of. Apparatus for the Safe Determination of the Decomposition or Explosion Point of Explosive Substances (Apparat zur gefahrlosen Bestimmung des Zersetzungs- oder Verpuffungspunktes explosiver Substanzen), A. Langhans. Zeit. für das gesamte Schiess- u. Sprengstoffwesen, vol. 15, no. 15, Aug. 1, 1920, pp. 161–163, 2 figs. Points out that the Wood metal bath usually employed for this purpose has the disadvantage that with the explosion of the substance a part of the melted, red-hot metal is hurled out, whereby either accidents occur to the investigators, or apparatus is soiled; and describes new apparatus with lead or aluminum blocks, designed to mitigate this danger.

EXPORT TRADE

Statistics. Export and Import Statistics Indicate Industrial Trend. O. M. Fox. Eng. News-Rec., vol. 85, no. 18, Oct. 28, 1920, pp. 835–836, 1 fig. It is concluded from survey of figures, that imports are rapidly increasing to a point where United States will no longer occupy a favorable trade position.

F

FACTORY MANAGEMENT

See INDUSTRIAL MANAGEMENT.

FARM MACHINERY

Improvements in. Agricultural Machinery, Gustav Fischer. Eng. Progress, vol. 1, no. 10, Oct. 1920, pp. 301–304, 9 figs. Improvements in thrashing machines, straw presses, chaff cutter and bruising mills.

FATIGUE

Industrial. The Speed of Adaptation of Output to Altered Hours of Work, H. M. Vernon. Eng. and Indus. Management, vol. 4, no. 15, Oct. 7, 1920, pp. 450–451. Data on evidence obtained at British munition factories during war. (Abstract.) Report of British Industrial Fatigue Research Board.

FILTRATION PLANTS

Operation. Filter Underdrain, Sand-Bed and Wash-water Experience. Eng. News-Rec., vol. 85, no. 20, Nov. 11, 1920, pp. 934–939. Symposium on current practice and operating success with various details of mechanical or rapid water filtration plants. (To be continued.)

FIRE BOATS

Diesel-Electric vs. Steam. Diesel-Electric Propulsion Versus Steam for Fire-Boats, William H. Easton. Motorship, vol. 5, no. 11, Nov. 1920, p. 997. Diesel electric is found more advantageous.

FIRE PROTECTION

Fire-Alarm Stations. A Central Fire-Alarm Station, C. W. Geiger. Jl. Electricity, vol. 45, no. 9, Nov. 1, 1920, pp. 432–434. San Francisco station.

Underwriters' Laboratories. Underwriters' Laboratories' Protection Department, W. C. Robinson. Nat. Fire Protection Assn., vol. 14, no. 2, Oct. 1920, pp. 141–145. Survey of work of protection Department of Underwriters' Laboratories.

FLIGHT

Soaring. Mechanical Equivalents of Soaring Flight. English Mechanic, vol. 112, no. 2902, Nov. 5, 1920, pp. 172–173. Circular tea-tray with deep rim in which heavy ball is rolled rapidly, motion being kept going by working tea-tray round in small circle. Ball's going round over tray is analogous to bird's gliding round at steady headway through air, friction force opposing bird corresponding to head resistance of opposing bird, and circular movement of tray corresponding to centrifugal propulsive force arising from small circular movement of air.

FLOW OF FLUIDS

Pipe Lines. Effect of Fittings on Flow of Fluids Through Pipe Lines, E. Foster. Mech. Eng., vol. 42, no. 11, Nov. 1920, pp. 616–618, 11 figs. Graphical solution of Babcock's formula for flow of steam in pipe lines. Tables giving equivalent lengths of standard pipe to allow for various screw fittings in conduits carrying non-viscous liquids, steam, air or gas.

FLOW OF WATER

Drain Tiles. New Formula for Flow of Water in Drain Tile. Eng. and Contracting, vol. 54, no. 15, Oct. 13, 1920, pp. 374–375, 1 fig. Formula derived from experiments in which 824 separate tests were made. From Bulletin 854 of U. S. Dept. of Agriculture.

Manning's Formula. Charts for Solution of Manning's Hydraulic Formula, Elmo G. Harris. Eng. News-Rec., vol. 85, no. 18, Oct. 28, 1920, pp. 837–839, 2 figs.

Theory of. On a Theory of Fluid Friction and Its Application to Hydraulics, E. Parry. English Elec. Jl., vol. 1, no. 4, Oct. 1920, pp. 146–164, 4 figs. Generalization of theory of fluid friction employed in aeronautics to flow of water in pipes and conduits. Table giving values of coefficient in Chézy's formula for flow of water in pipes and conduits.

FOREIGN TRADE

Prospects for. Prospects for Foreign Trade, A. H. Holliday. Iron Age, vol. 106, no. 18, Oct. 28, 1920, pp. 1106–1107. Statistics show loss of steel production to peaceful arts during war. (Abstract.) Paper read before Am. Iron & Steel Inst.

FORGING

Recording Apparatus. The Solution of Forging Problems, Eugene Schneider. Eng. & Industrial Management, vol. 4, no. 17, Oct. 21, 1920, pp. 520–525, 2 figs. Schneider apparatus for recording times and pressures employed during forging in relation to the stroke.

FOUNDRIES

Accidents in. See ACCIDENTS, Foundries.

Brass. Reclamation of Metal from Brass-Foundry Refuse, F. L. Wolf and G. E. Alderson. Metal Industry (N.Y.), vol. 18, no. 10, Oct. 1920, pp. 452–455, 2 figs. Records of costs and returns obtained in reclaiming plant used at Ohio Brass Co. Paper read before Inst. of Metals Division.

See also RAILWAY SHOPS, Brass Castings for.

British. English Foundry Makes Rail Chairs, H. Cole Estep. Foundry, vol. 48, no. 18, Sept. 15, 1920, pp. 733–740, 13 figs. Quantity production methods employed. Molds are made on roll-over, stripping-plate machines of special design; cupolas melt continuously.

Scrap Utilization in. Utilization of Scrap from Iron and Steel Foundries, with Special Regard to the Recovery of Scrap Iron from Rubbish (Die Verwertung von Abfällen aus Eisen- und Stahlgiessereien insbesondere die Rückgewinnung des Abfalleisens aus dem Schutt), Hubert Hermanns. Dinglers polytechnisches Jl., vol. 335, no. 17, Aug. 21, 1920, pp. 185–188, 7 figs. Notes on the electro-magnetic separation of rubbish for the recovery of iron, conditions for which are said to be most favorable in plants where low-voltage direct-current is available as the magnets can be excited only with direct-current. Details of different construction types.

U. S. and Canada. Growth Marks Reconstruction Era. Foundry, vol. 48, no. 21, Nov. 1, 1920, pp. 853–858, 7 figs. List of foundries in United State and Canada in 1920 and 1918 by States and Provinces.

FUELS

Coal vs. Oil. See COAL, Oil vs.

Diesel-Engine. See DIESEL ENGINES, Fuels.

Purchasing of. Premiums for Dry Fuel (Prëmien für trockenen Brennstoff), G. Höhn. Zeit. des Bayerischen Revisions-Vereins, vol. 24, no. 16, Aug. 31, 1920, pp. 125–128, 2 figs. A formula is derived and recommended for calculating gain in value of fuel delivered to purchaser in dryer condition than agreed upon, or loss in value when delivered in more moist condition.

FURNACES, BOILER

Forced Draft. Draft Regulation in Forced-Draft Boiler Furnaces (Windregelung bei Unterwindfeuerungen), H. Pradel. Zeit fur Dampfkessel u. Maschinenbetrieb, vol. 43, no. 36, Sept. 3, 1920, pp. 273–275, 5 figs. Details of air-current regulator developed by German Evaporator Co., Ltd., by means of which air admitted into every chamber can be regulated.

FURNACES, ELECTRIC

See ELECTRIC FURNACES.

FURNACES, HEAT-TREATING

Insulation. The Function of Insulation and its Application to Heat Treating Furnaces, E. F. Davis. Trans. Am. Soc. for Steel Treating, vol. 1, no. 1, Oct. 1920, pp. 33–42, 4 figs. Formulæ and graph for designing insulation.

FURNACES, OPEN-HEARTH

Efficiency. Increased Efficiency in the Open Hearth, Philip C. Gunion. Blast Furnace & Steel Plant, vol. 8, no. 11, Nov. 1920, pp. 624–625, and p. 635, 3 figs. Effect roller bearings applied to rolling stock has upon reducing transportation costs. Comparative tests made with cars of plain bearing type.

Port Design. Design of Ports for Open Hearth Furnaces, Herbert F. Miller, Jr., Blast Furnace & Steel Plant, vol. 8, no. 11, Nov. 1920, pp. 612–614, 3 figs. Circular water cooled ports used by Lackawanna Steel Co.

G

GAGES

Laboratory Standards. Sizes of the N. P. L. End Standards in English Units. Eng. vol. 110, no. 2858, Oct. 8, 1920, p. 474. Changes which have been made in accepted sizes of laboratory end standards at National Physical Laboratory, England.

Lapping. See LAPPING.

Precision. Precision Gages, M. E. Kanek. Am. Mach., vol. 53, no. 20, Nov. 11, 1920, pp. 884–886. Methods of accurate measurement, and methods of manufacturing precision gages.

Precision Measuring and Inspection Devices—II, R. J. Whibley. Machy. (N.Y.), vol. 27, no. 3, Nov. 1920, pp. 242–245, 6 figs. Minimeter and gage comparator used by National Physical Laboratory, England, for inspecting precision gage-blocks. Devices permit readings to accuracy of one millionth of an inch.

Thread. Adjustable Thread Snap Gauge. Eng., vol. 110, no. 2860, Oct. 22, 1920, pp. 551, 3 figs. Constructed by Coventry Gauge & Tool Co., Ltd., Engineers, Coventry.

GARBAGE DISPOSAL

Methods. Transportation of Garbage with Data on Garbage Disposal in Various Cities, Samuel A. Greeley. Mun. & County Eng., vol. 59, no. 4, Oct. 1920, pp. 132–134. Tables showing method of garbage disposal in 50 of largest cities in U. S.

GAS MAINS

Steel vs. Cast Iron. Steel Versus Cast-Iron for Gas Mains, B. R. Parkinson and Norton H. Humphrys. Gas World, vol. 73, no. 1891, Oct. 16, 1920, pp. 299–300. Opinions of representative engineers.

GAS MANUFACTURE

Regulations in France. New Regulations for the Quality of Illuminating Gas, and New Methods of Manufacture (Nouvelles règles fixant les qualitiés exigées du gaz d'éclairage, et nouvelles méthodes de fabrication), P. Lauriol. Génie Civil, vol. 77, no. 17, Oct. 23, 1920, pp. 328–329. Suppression of tests of illuminating power and permission to add water gas.

GAS MASKS

Uses in Mines. Danger in Using Army Gas Masks in Mines, George S. Rice. Reports of investigations, Bur. of Mines, Dept. of Interior, serial no. 2175, Oct. 1920, 2 pp. Instances of failure of army gas mask.

GAS PRODUCERS

German. Modern Development of Fuel Gasification, Hubert Hermanns. Blast Furnace & Steel Plant, vol. 8, no. 11, Nov. 1920, pp. 617–624, 13 figs. Development of modern gas producers in Germany. Operation of producer and processes by which complete utilization of all constituents are obtained.

Tar Recovery. Gas-Producer Plants Equipped for Recovery of Low-Temperature Tar (Die Gaserzeugungsanlagen mit Gewinnung von Urteer), E. Roser. Zeit. des Vereines deutscher Ingenieure, vol. 64, no. 42, Oct. 16, 1920, pp. 857–864, 8 figs. Account of tests carried out by the Thyssen & Co. Machine Factory in Mülheim during years 1916–1918. Notes on yield of by-products; determination of extraction of heat from coal; utilization of by-products; future possibilities of process; the use of cold gas in foundry furnaces and in the generation of power; increase in consumption of coal through recovery of by-products.

ENGINEERING INDEX (Continued)

GAS WARFARE

Mustard Gas. Decomposition of and Pressure Developed by Mustard Gas in Steel Shell at 60 deg. cent., W. A. Felsing, H. Odeen and C. B. Petersen. Jl. Indus. & Eng. Chem., vol. 12, no. 11, Nov. 1920, pp. 1063–1065, 4 figs. It was found that decomposition of both process A (original 60 deg.-cent. process) and process B (Levinstein) mustard gas takes place in steel shell at 60 deg. cent., but extent of decomposition is not serious even under severe conditions.

The Precipitation of Sulfur from Crude Mustard Gas by Means of Ammonia, W. A. Felsing and S. B. Arenson. Jl. Indus. & Eng. Chem., vol. 12, no. 11, Nov. 1920, pp. 1065–1066. Addition of moist ammonia caused precipitation of about 40 to 45 per cent of total supposedly free sulphur.

Repelling Poisonous Gases. Repelling Poisonous Gases. Sci. Am. Monthly, vol. 2, no. 3, Nov. 1920, pp. 235–236. Fanning system that was used to clear trenches after gas attack.

GAS WORKS

Motive Power. Notes on Operating a By-Product Producer Gas Plant for Power and Heating, W. H. Patchell. Jl. Instn. Elec. Engrs., vol. 58, no. 292, June 1920, pp. 417–430 and (discussion) pp. 437–463, 4 figs. Extension of gas works of Hoffmann Manufacturing Co., Ltd., England.

Waste Disposal. Disposal of Waste from Gas Plants. Am. Gas Eng. Jl., vol. 113, no. 19, Nov. 6, 1920, pp. 363–366. Report of American Gas Association 1920 Committee.

GASOLINE

Alcogas Fuel vs. Comparison of Alcogas Aviation Fuel with Export Aviation Gasoline, V. R. Gage, S. W. Sparrow and D. R. Harper, 3d. Nat. Advisory Committee for Aeronautics, report no. 89, 1920, 14 pp. 47 figs. Tests showed at 5.6 compression the same maximum power production at ground level and general average of 4 per cent more power at altitude for alcogas, maximum difference being about 6 per cent at 6400 ft. and 1800 r.p.m. At 7.2 compression alcogas showed average and fairly uniform increase of 4 per cent in power at altitude.

Carburation of. The Carburation of Gasoline, O. C. Berry and C. S. Kegerreis. Purdue University, Publications of Eng. Depts., vol. 4, no. 1, April 1920, 223 pp., 103 figs. Results of tests carried out to determine richness of fuel to air mixture required by engine under different running conditions in order that it may develop either maximum power or maximum efficiency.

Cracking Manufacturing Practice. Gasoline Cracking Processes, Fred W. Padgett. Chem. & Metallurgical Eng., vol. 23, no. 19, Nov. 10, 1920, pp. 908–913. Description of commercial methods for production of gasoline by pyrolytic distillation of heavy hydrocarbons, including Burton, Greenstreet, Hall, Rittman, Aluminum Chloride, Dubbs, Jenkins, and Bacon processes. List of inventors, patent numbers and dates.

GASOLINE ENGINES

Horsepower Diagram. Diagram to Determine Horsepower of Gasoline Engines, C. E. Lounsberg. Eng. News-Rec., vol. 85, no. 19, Nov. 4, 1920, pp. 892–893, 1 fig. It is held that Swedish formula is best for purpose.

GASOMETERS

Wind Pressure on. The Effect of Wind Forces on Gasometers. (Windkräfte auf Gasbehälter). Jl. für Gasbeleuchtung u. Wasserversorgung, vol. 63, no. 35, Aug. 28, 1920, pp. 566–567, 3 figs. It is concluded that distribution of pressure on smooth model without limitation of bottom cannot be wholly accepted for actual practice; the total resistance of air on an actual gasometer has probably a different value from that resulting from calculation with the coefficient of a model.

GEARS

Automobile. Fixtures for Testing Automobile Gears. Machy. (N. Y.), vol. 27, no. 3, Nov. 1920, pp. 270–273, 8 figs. Methods used at various plants.

Teeth in Contact. Derivation of a Formula to Determine Number of Teeth in Contact of Two Meshing Gears, A. B. Cox. Am. Mach., vol. 53, no. 20, Nov. 11, 1920, pp. 899–902, 10 figs. Formula is derived and graphic representations of results of application of this formula are shown.

GIRDERS

Design. The Stresses in Portals and Similar Structures, Talbot C. Broom. Engr., vol. 130, nos. 3381 and 3382, Oct. 15 and 22, 1920, pp. 368–369, 5 figs., and 393–394, 5 figs. Suggests simplification in design of continuous girders.

GLASS

Expansion at High Temperatures. The Expansion of Glass at High Temperatures, W. B. Pietenpol. Chem. & Metallurgical Eng., vol. 23, no. 18, Nov. 3, 1920, pp. 876–877, 1 fig. Thermal expansion curves of unannealed light barium crown glass.

GOLD METALLURGY

Recovery from Black Sand Tailings. Recovery of Gold from Black Sand Tailings, John Gross. Reports of Investigations, Bur. of Mines, Dept. of Interior, serial no. 2170, Oct. 1920, 2 pp. Tests conducted at Alaska station of Bur. of Mines.

GOLD MINING

Southern U.S. Gold Mining in the Southern States, H. A. Megraw. Eng. & Min. Jl., vol. 110, no. 20, Nov. 13, 1920, pp. 938–940, 1 fig. Recent development of mines in that section hindered by absence of mining code, lack of mining experience, and failure to recognize limitations.

GRINDING

Automobile Parts. Cadillac Grinding Practice. Machy. (Lond.), vol. 17, no. 420, Oct. 14, 1920, pp. 33–37, 9 figs. Methods employed in grinding department of plant building Cadillac cars.

GRINDING MACHINES

High-Speed. Grinding at Speed of 100,000 Revolutions per Minute. Can. Machy., vol. 24, no. 16, Oct. 14, 1920, p. 365. Editorial comment on machine produced by British manufacturer which is said to be capable of running safely at 100,000 r.p.m.

H

HARBOR IMPROVEMENTS

Dutch Indies. The Use of Reinforced Concrete for Harbor Construction in the Dutch Indies (Verwendung von bewehrten Beton zu Hafenbauten in Niederländisch-Indien), A. v. Horn. Zentralblatt der Bauverwaltung, vol. 40, no. 72, Sept. 8, 1920, pp. 453–455, 10 figs. Describes extended use of reinforced concrete for piles, caissons for quay walls, storage sheds, loading wharves, etc., including notes abstracted from paper on the technical problems of Indian harbor construction by Wouter Cool (de Ingenieur, no. 8, 1919).

HARMONICS

Analysis. A Practical Method of Harmonic Analysis, Philip Kemp. Jl. Instn. Elec. Engrs. (Supplement), vol. 57, part 2, Oct. 1920, pp. 85–91. Schedule for routine work in analysis of periodic wave forms.

HEAT TRANSMISSION

Radiation. Radiation and Convection from Heated Surface, T. Barratt and A. J. Scott. Physical Soc. of London, Proc., vol. 32, part 5, Aug. 15, 1920, pp. 361–373, 2 figs. Experimental determination was made of amounts of natural convection and radiation from cylindrical and spherical surfaces heated in air at atmospheric temperature and pressure to temperature of about 100 deg. cent. Convection alone was found to be inversely proportional to square root of diameter of cylinder and to cube root of diameter of sphere.

HEATING AND VENTILATION

Humidity Regulator. An Automatic Humidity Regulator (Der selbsttätige Luftfeuchtigkeitsregler "Humidostat"). Gesundheits-Ingenieur, vol. 43, no. 26, June 26, 1920, pp. 306–307, 6 figs. Describes humidostat constructed by the Automatic Temperature Regulation Co., Ltd., Berlin-Friedenau, in which the compressor generates the necessary compressed air and operates in such a manner that when temperature corresponding to 1 atm. above pressure is reached, the movement of compressor ceases and is automatically resumed at lower atmospheric pressure. Points out its many useful possibilities.

Psychrometric Chart. Psychrometric Chart, E. V. Hill. Heating and Vent. Mag., vol. 17, no. 10, Oct. 1920, pp. 50–51, 1 fig. Issued by Chicago Department of Health.

Schools. New Heating and Ventilating System Adopted for Chicago Schools—I. Domestic Eng., vol. 93, nos. 6 and 7, Nov. 6 and 13, 1920, pp. 251–253, 3 figs, and 300–302, 14 figs. Plan recently evolved by chief engineer of Chicago Board of Education.

HEAVY-OIL ENGINES

Reciprocating Parts for. Reciprocating Engine Crosshead Design Applied to Heavy Oil Engines, W. D. Forbes. Marine Eng., vol. 25, no. 11, Nov. 1920, pp. 924–925. Service requirements.

HOBS

Worm-Wheel, Standardization of. Standardization of Worm-Wheel Hobs (Ueber die Normung von Schneckenradfräsern), Fr. Woltzendorff. Betrieb, vol. 2, no. 14, Aug. 1920, pp. 347–352, 6 figs. Advantages of standardization are said to be that the cutters can be fabricated in quantities, are cheaper, more accurate in pitch and boring and interchangeable; worms can be forged and cut in quantities, thus effecting a great saving in time and labor.

HOISTING ENGINES

Standardization. Standardization of Hoisting Machines (Normung von Hebezeugen), Karl Engel. Betrieb, vol. 2, no. 16, Sept. 1920, pp. 417–420. Points out its great advantages from economic standpoint and makes recommendations for calibrated load and hand chains and for gage dimensions.

The Standardization of Hoisting Machines (Die Vereinheitlichung der Hebemaschinen), Leopold Feigl. Betrieb., vol. 2, no. 14, Aug. 1920, pp. 377–380. Discusses program submitted by working committee for standardization of hoisting machines of the N D I, and offers suggestions for extending limits in some cases. Recommendations for standardization of trestle bridges and electrically driven traveling crabs.

HOSE

Steam. Steam Hose Construction, John M. Bierer. India-Rubber Jl., vol. 60, no. 15, Oct. 9, 1920, pp. 9–10. Results obtained from tests by B. F. Goodrich Co. Hose constructed according to different processes were compared.

HOUSES

Electrical Equipment. The Electrical Equipment of Artisan Dwellings, Leonard Milne. Jl. Instn. Elec. Engrs., vol. 58, no. 292, June 1920, pp. 464–467 and (discussion), pp. 476–490. Cost figures for electrical equipment supply to houses erected under British Government Housing scheme.

HOUSES, CONCRETE

Construction. Concrete Cottage Building. Concrete and Constructional Eng., vol. 15, no. 10, Oct. 1920, pp. 668–673, 7 figs. Patent system of construction approved by British Ministry of Health.

HOUSING

England. English Efforts to Solve the Housing Problem since the War (Englische Bestrebungen zur Behebung der Wohungsnot nach dem Kriege), Stephan Prager. Zeitschrift für Bauwesen, vol. 70, no. 7–9, 1920, pp. 414–499, 87 figs. Notes on government board for building aid; work of government in overcoming the housing shortage; temporary relief measures through use of barracks, framework buildings and rebuilding of single-family houses into renting apartments; building costs, and material and labor supply; recommendations for substitute building materials and new building methods; success up to present time of the housing policy and future prospects. Bibliography.

France. Low-Priced Houses (La construction d'habitations à bon marché), Paul Razous. Génie Civil, vol. 77, no. 16, Oct. 16, 1920, pp. 309–313. Housing projects for Paris and suburbs.

HUMIDITY

See HEATING AND VENTILATION, Humidity Regulator; Psychrometric Chart.

HYDROELECTRIC PLANTS

New Brunswick, Canada. Hydro-Electric Power Development in New Brunswick, C. O. Foss. Jl Eng. Inst. Canada, vol. 3, no. 11, Nov. 1920, pp. 522–525. Outlines work at Musquash River and Shogomac developments.

Niagara Falls Power Development. Clearing House for Five Stations, J. Allen Johnson. Elec. World, vol. 76, no. 20, Nov. 13, 1920, pp. 961–965, 12 figs. Semi-outdoor substation of Niagara Falls Power Co. Combined output of installations is rated at 400,000 hp.

Norway. Vamma Hydro-Electric Plant. Engr., vol 130, no. 3379, Oct. 1, 1920, pp. 324–326, 3 figs Plant, when completed, will develop 200,000 hp on head of from 80 ft. to 85 ft.

I

IGNITION

Alsop Device. Test of the Alsop All-Spark Ignition Device. Air Service Information Circular, vol. 1, no. 18, Sept. 15, 1920, 4 pp., 1 fig. Device is subsidiary spark gap which is inserted in high-tension circuit of ignition system.

Sparking Performance of System. The Effect of Shunted Resistance, or Plug Leakage, on the Sparking Performance of an Electrical Ignition System, G. E. Bairsto. Jl. Instn. Elec. Engrs., vol. 58, no. 292, June 1920, pp. 507–522, 22 figs. Tests made at Royal Aircraft Establishment, Farnborough, England, during 1917 to 1918, to determine effect of shunted resistance on spark voltage of most of leading types of electrical ignition systems in use. It was found that the quicker the rate of rise of secondary potential the less is fall of voltage with leakage. Following order of merit of various types was established: (1) rotating armature types with movable pole-shoes, (2) ordinary rotating-armature types, (3) sleeve inductor types, (4) polar inductor types; and (5) battery and coil systems.

Tests. Ignition from the Engineman's Viewpoint, George E. A. Hallett. Jl. Soc. Automotive Engrs., vol. 7, no. 5, Nov. 1920, pp. 475–479, 7 figs. Test results of single and double ignition systems on Liberty engine.

INDUSTRIAL MANAGEMENT

Inspection. Inspection: The Control of Quality—III George S. Radford. Indus. Management, vol 60, no. 5, Nov. 1920, pp. 331–335. Comparative study of various methods of inspection, such as centralized inspection, floor inspection, inspection of work in process, sampling, double inspection, pilot part tests, etc.

Opinions of Workers. What the Workers Think About Management—I, Albert Fry. Indus. Management, vol. 60, no. 5, Nov. 1920, pp. 322–327. Views of labor turnover, rate setting and managing men by ironworkers, carpenters, inspectors, blacksmiths, machinists, patternmakers and others.

Payroll Graph. Graphic Planning of Payroll Procedure, W. C. Bober. Indus. Management, vol. 60, no. 5, Nov. 1920, pp. 336–337, 1 fig. Chart based on labor routine of Mechanical Rubber Co., Cleveland.

Planning Department. New Department in Detroit Plant, Don F. Kennedy. Iron Age, vol. 106, no. 19, Nov. 4, 1920, pp. 1177–1179. Duties of factory planning engineer at Timken-Detroit Axle Co.'s Detroit plant.

Planning Department Systems, John H. Van Deventer. Indus. Management, vol. 60, no. 5, Nov. 1920, pp. 373–376, 4 figs. How to visualize methods by mapping routine.

Production Systems. How a Factory Diplomat Aids Production. Factory, vol. 25, no. 9, Nov.

ENGINEERING INDEX (Continued)

1, 1920, pp. 1398-1400, 1 fig. Production methods of foundry in Illinois.

Modern Production Methods, W. R. Basset. Am. Mach., vol. 53, nos. 18 and 20, Oct. 28 and Nov. 11, 1920, pp. 798-802, 3 figs., and 889-891, 2 figs. Fundamental definitions and explanations of cost subdivision. Nov. 11: Method of allotting fixed charges to every department.

Routing Materials. Routing Considered as a Function of Up-to-Date Management—II, H. K. Hathaway. Indus. Management, vol. 60, no. 5, Nov. 1920, pp. 353-361, 10 figs. How to proceed when product consists of several parts.

Shipyards. Scientific Management in a Large French Shipyard—I, M. Lavallee. Eng. & Industrial Management, vol. 4, nos. 17 and 18, Oct. 21 and 28, 1920, pp. 515-519, 1 fig., and 547-553, 7 figs. Results obtained in 1914 at Penhoet Shipyard at St. Nazaire, France. From Bulletin de la Société d'Encouragement pour l'Industrie Nationale.

INDUSTRIAL RELATIONS

Employees' Magazines. Making the Plant Paper Pay, Edwin A. Hunger. Indus. Management, vol. 60, no. 5, Nov. 1920, pp. 341-344. Suggestions to editors of employees' magazines.

Employers' Control. Italy's Soviet Shows Weakness, Francis Miltoun. Iron Trade Rev., vol. 67, no. 19, Nov. 4, 1920, pp. 1271-1272. Collapse of short-lived uprising of workers in steel plants and factories is pointed out as illustrating interdependence of capital and labor.

Open-Shop Movement in U. S. Cleveland in Open-Shop Ranks. Iron Trade Rev., vol. 67, no. 19, Nov. 4, 1920, pp. 1264-1265. It is reported American Plan Association has been organized, with fully 70 per cent of employers coöperating.

Employes Uphold the Open Shop, A. J. Hain. Iron Trade Rev., vol. 67, no. 16, Oct. 14, 1920, pp. 1071-1076, 7 figs. How International Association of Machinists failed to obtain general advance of 25 per cent in wages for which it fought for a year at Cincinnati machine tool plants.

New Open-Shop Movement in Cleveland. Iron Age, vol. 106, no. 19, Nov. 4, 1920, pp. 1201-1202. American Plan Association was recently organized. Purpose of organization is to establish open shop principle in industrial relations.

Public Sponsors Open-Shop Associations. Iron Trade Rev., vol. 67, no. 20, Nov. 11, 1920, pp. 1339-1345 and pp. 1348-1350, 5 figs. It is reported that American Federation is to be established soon. Purpose of federation will be to secure and establish open-shop principle in industrial relations.

Open Shops, Arguments in Favor of. The Human Factor in Industry, Alexander Ramsay. Jl. Inst. Mech. Engrs., no. 6, Oct. 1920, pp. 709-715 and (discussion) pp. 716-729. Urges employers to cultivate more open shop policy.

Settlement of Disputes. The Settlement of Labor Disputes, Henry J. Allen. Elec. Ry., Jl., vol. 56, no. 16, Oct. 16, 1920, pp. 751-753. Experience in Kansas cited to illustrate fundamental relations of workers and public welfare.

Unionized Shops. An Example of Putting Friendliness into a Unionized Shop, Harry Tipper. Automotive Industries, vol. 43, no. 18, Oct. 28, 1920, pp. 882-883. Writer quotes from English employer to show that open shop is not necessary to arrive at complete accord between workers and management.

Whitley Shop Councils. See EMPLOYEES' REPRESENTATION, Shop Committees.

INDUSTRIAL RAILWAYS

Factory Railway System. Conveying in Factories with Special Regard to Works Railway Operation (Das Transportwesen in Fabriken mit besonderer Berücksichtigung des Werkbahnbetriebes), R. Kampe. Betrieb, vol. 2, no. 15, Aug. 1920, pp. 405-407, 2 figs. Gives general fundamental principles and requirements, which should be considered in the organization of a transportation system, especially of a factory railway system.

INDUSTRIAL TRUCKS

Steel Industry. Trucks Win Place in Steel Traffic as Railroads Fail, Myers L. Feiser. Iron Trade Rev., vol. 67, no. 17, Oct. 21, 1920, pp. 1127-1129, 5 figs. Steel carried in motor trucks from mill to consumer or to car for shipment to consumer is estimated at more than 100,000 tons monthly.

INDUSTRY

Australia. The Industrial Development of Australia, Ernest L. Little. Am. Mach., vol. 53, no. 19, Nov. 4, 1920, pp. 842-843. Statistics showing progress within last ten years.

Mexico. Mexico's Industrial Progress Since Diaz, John E. Kelly. Eng. & Min. Jl., vol. 110, no. 20, Nov. 13, 1920, pp. 941-943. Nearly all railroad construction now under way planned under Carranza. Oil exports tripled in seven years. Metal output during revolutionary period indicative of mining activities.

INSULATORS

European Practice. Features of European Insulator Testing Practice, B. Schapira. Elec. Rev., (Chicago), vol. 77, no. 19, Nov. 6, 1920, pp. 721-724, 8 figs. Two-part insulators of pin type are used for service below 70,000 volts. Tests are made of electrical and mechanical properties of individual parts and complete assembled units. Testing practice as carried on in Schomburg Works at Margarethenhutte, Germany.

High-Voltage. Surface Creepage and High-Voltage Insulation, T. Nishi. Jl. Am. Inst. Elec. Engrs., vol. 39, no. 11, Nov. 1920, pp. 949-959, 32 figs. Experiments made in Electrical Engineering Laboratory in Tokyo Imperial University and in High-Voltage Laboratory of Leland Stanford Junior University. It is concluded that main cause of erratic surface creepage is accumulation of free charge on surface of dielectric of which bushings insulators, etc., are made.

Testing. Testing Insulators in Factory and Field, Leslie N. Crichton. Elec. Jl., vol. 17, no. 11, Nov. 1920, pp. 506-509, 10 figs. Methods of Westinghouse Elec. & Mfg. Co.

INTERCHANGEABLE MANUFACTURE

Selective Assembly vs. Manufacturing for Selective Assembly, Earle Buckingham. Machy. (Lond.), vol. 17, no. 421, Oct. 21, 1920, pp. 82-83, 2 figs. Comparison of interchangeable and selective assembly manufacturing methods. Dimensions and tolerances on drawings for manufacturing on selective assembly basis.

Tolerances. Size Tolerances and Allowance Tolerance (Grössentoleranzen und Passungstoleranz), J. Kirner. Betrieb, vol. 2, no. 16, Sept. 1920, pp. 426-427, 4 figs. The preliminary conditions for unlimited interchangeability. Points out that so-called allowance tolerance or inaccuracy of an allowance is result of the algebraic difference between maximum and minimum excess measurement or play of allowance.

INTERNAL-COMBUSTION ENGINES

Compound Type. Pourcel Compound Explosion Motor (Moteur compound à explosion, système Pourcel). Génie Civil, vol. 77, no. 15, Oct. 9, 1920, p. 299, 1 fig. Patented engine with two explosion cylinders and an expansion cylinder where explosion gases expand before being exhausted in atmosphere.

Cooling Devices. New Devices for the Cooling of Internal-Combustion Engines (Neue Luftkühler für Verbrennungsmotoren,) H. Pradel. Zeit. für Dampfkessel u. Maschinenbetrieb, vol. 43, nos. 31 and 34, July 30 and Aug. 20, 1920, pp. 233-234 and 260-262, 17 figs. Details of various new patents.

The Cooling of Internal-Combustion Engine. (Die Kühlung der Verbrennungsmotoren), H. Praetorius. Motorwagen, vol. 23, no. 23, Aug. 20, 1920, pp. 425-429, 12 figs. Review of new patents and devices in the field of engine cooling introduced for the purpose of increasing economy of engines and in view of the frequent necessity of employing heavier fuel.

Valves, Steel for. Steel for Valves of Combustion Motors, G. Gabriel. Iron Age, vol. 106, no. 20, Nov. 11, 1920, pp. 1249-1251. Requirements enumerated in light of troubles which experience has discovered in low weight engine. (To be continued.) Translated from La Technique Automobile et Aerienne.

[See also AEROPLANE ENGINES; AUTOMOBILE ENGINES; DIESEL ENGINES; GASOLINE ENGINES; HEAVY-OIL ENGINES; OIL ENGINES; SEMI-DIESEL ENGINES.]

IRON

Electrolytic. Reheating of Electrolytic Iron (Le recuit du fer électrolytique), Jeane Cournot. Revue de Métallurgie, vol. 17, no. 8, Aug. 1920, pp. 568-570, 6 figs. Experimental study of best procedure to remove hydrogen remaining in iron when issuing from electrolytic bath.

Soft. Soft Iron (Ueber Weicheisen), P. Goerens and P. Fischer. Betrieb, vol. 2, no. 16, Sept. 1920, pp. 432-436, 20 figs. Account of mechanical and physical investigations of the nearly chemically pure WW soft iron produced in the open-hearth furnaces of the Fried. Krupp Works in Essen-Ruhr, the elasticity and shock resistance of which in cold state is said to exceed that of all kinds of mild steel produced in large quantities, and in many cases is a perfect substitute for copper. Abstracted from the Krupp Monthly Jl. (Jan. 1920).

IRON CASTINGS

Cleaning with Sand Blast. The Sand Blast in the Foundry, O. Bertoya. Metal Industry (Lond.), vol. 17, no. 17, Oct. 22, 1920, pp. 321-323, 9 figs. Comparative tests of time required to clean castings by hand and by sand blasting.

Standardization of. Standardizing of Gray Iron Samples, Edward J. Fowler. Foundry, vol. 48, no. 21, Nov. 1, 1920, pp. 876-877. It is said that lack of recognized standards which specify method of taking samples of gray iron castings for test purposes greatly impairs work of laboratory.

IRON METALLURGY

Direct Process. A Direct Process for Making Iron and Steel from Ore, James W. Moffat. Iron and Steel of Can., vol. 3, no. 9, Oct. 1920, pp. 271-274, 3 figs. Process patented by writer, in which reduction is accomplished in separate mechanism and melting down of metal and its subsequent refining take place in electric furnace. Blast furnace is eliminated and metal reduced from ores of all types. Process is said to be applicable to certain non-ferrous metals.

IRON ORE

Australian. The Iron Ore Deposits at Yampi Sound, West Australia, A. Montgomery. Min. Mag., vol. 23, no. 4, Oct. 1920, pp. 203-122, 12 figs. Description of iron ore deposits on Koolan and Cockatoo Islands situated in Yampi Sound off nothern coast of West Australia.

Canadian. Iron Ores of Commerce with Special Reference to Canadian Deposits, Samuel Groves. Iron and Steel of Can., vol. 3, no. 9, Oct. 1920, pp. 267-270, 1 fig. Classification of commercial iron ores. (To be continued.) Report of Ontario Bureau of Mines.

IRRIGATION

Canada. The Legal Phases of Irrigation Development in Alberta, H. B. Muckleston. Jl. Eng. Inst. Canada, vol. 3, no. 11, Nov. 1920, pp. 510-514. History of irrigation law in general, developments in Alberta, and procedure under present laws.

Washington State. Unprecedented Design Involved in Irrigation Project. Eng. News-Rec., vol. 85, no. 20, Nov. 11, 1920, pp. 944-946, 2 figs. To bring water 130 miles to 1,753,000-acre Columbia basin in Washington. Viaduct, siphons and tunnels of unusual size.

L

LABOR

International Action Affecting. Historical Survey of International Action Affecting Labor, U. S. Dept. of Labor, Bur. of Labor Statistics, no. 268, Aug. 1920, 294 pp. Includes brief account of international political labor movement as seen in early International and its later organization as International Socialist Bureau. Describes briefly international trade-union movement, international organizations of "social reformers" interested in labor problems, considering particularly International Association for Labor Legislation, and recounts efforts of Governmental conferences to arrive at agreements as respects control of labor conditions within their respective jurisdictions. Analysis is made of treaties and conventions entered into by various Governments. Survey covers international work up to 1914.

LAPPING

Modern Practice. Modern Lapping Practice, Edward K. Hammond. Machy. (N.Y.), vol. 27, no. 3, Nov. 1920, pp. 209-217, 19 figs. Review of developments in lapping practice including abrasives used and lap-charging methods, lapping thread gages, snap gages, measuring wires, flat surfaces, ring gages, die-casting dies, T-slots, etc.

LATHES

Turret. Tooling Acme Turret Lathes. Machy. (Lond.), vol. 17, no. 419, Oct. 7, 1920, pp. 1-5, 12 figs. Tooling equipment for performing turret-lathe operations on friction pulleys, aluminum pistons, gear blanks and other machine parts.

Turret Lathe Design and Construction. Mach. (Lond.), vol. 17, no. 420, Oct. 14, 1920, pp. 41-44, 5 figs. Based on examination of four American and one English machines.

LIGNITE

Briquetting. The Briquetting of Lignites, R. A. Ross. Dominion of Canada, report no. 1, 1918, 29 pp. Procedure and equipment are recommended.

Carbozite. The Low-Temperature Carbonization of Low-Grade Fuels, Especially of Lignites (Nochmals: Die Tieftemperaturverkohlung geringwertiger Brennstoff, insbesondere der Braunkohle), H. Bansen. Braunkohle, vol. 19, no. 17, Aug. 7, 1920, pp. 217-220. Refers to article by Theiler in same journal (vol. 18, no. 33, Nov. 15, 1919) on manufacture of carbozite, a lignite product whose heating value is said to be three times that of lignite. Critical discussion of its merits from technical and economical standpoint.

LIGHTING

Bibliography. Illumination Bibliography. Trans. Illuminating Eng. Soc., vol. 15, no. 7, Oct. 9, 1920, pp. 385-391. Prepared by Committee on education of Illuminating Eng. Soc. It covers books published in recent years up to June 1920.

Developments. Report of the Committee on Progress. Trans. Illuminating Eng. Soc., vol. 15, no. 7, Oct. 9, 1920, pp. 425-493. Extensive survey of recent developments in gas and electric light.

Electric Signs. Engineering Features of Electric Sign Lighting. Bul. Eng. Dept. Nat. Lamp Works, Gen. Elec. Co., bul. no. 15a, March 15, 1916, 35 pp., 20 figs. Engineering features involved in readability of electric signs, wiring of electric signs and cost of their operation.

Industrial. Industrial Lighting, Ward Harrison and H. H. Magdsick. Bul. Eng. Dept. Nat. Lamp Works, Gen. Elec. Co., bul. no. 20a, Sept. 10, 1919, 95 pp., 79 figs. Requirements which must be fulfilled in design of satisfactory installations. Data on Mazda lamps. Discussion of reflecting and diffusing equipment. Study of lighting of yards and foundries. Cost data of industrial lighting.

Modern Industrial Lighting for Oregon, F. H. Murphy. Elec. World, vol. 76, no. 17, Oct. 23, 1920, pp. 820-823, 5 figs. Features of industrial lighting code adopted by Oregon. Provision is made for raising standards as better lighting practice develops.

Proper Lighting Means Efficiency, James Brakes, Jr. Iron Trade Rev., vol. 67, no. 16, Oct. 14, 1920, pp. 1061-1062 and 1067, 2 figs. Self-cleaning lamp fixtures. (Abstract.) Paper read before Am. Foundrymen's Assn.

Machine Shops. Illumination of Machine Tools, G. Wagschal. Elec. World, vol. 76, no. 19, Nov. 6, 1920, pp. 925-926, 4 figs. Sufficient illumination is said to be obtained over machines with intensity of 15.35 ft. candles in plant of Central Gear Co.

Stores. Store Lighting. Bul. Eng. Dept. Nat. Lamp Works, Gen. Elec. Co., bul. no. 29, June 5, 1917, 40 pp., 14 figs. Discussion of various types

ENGINEERING INDEX (Continued)

of lighting systems with suggestions and tables of particular application in store-lighting problems.

Street. Street Series Alternating-Current Incandescent Lamp Circuits. Bul. Eng. Dept. Nat. Lamp Works, Gen. Elec. Co., bul. no. 25, Sept. 20, 1915. 23 pp. 11 figs. Factors in design and operation of streets series incandescent systems.

Street Series Mazda Lamps. Bul. Eng. Dept. Nat. Lamp Works, Gen. Elec. Co., bul. no. 11C, Oct. 15, 1915, 10 pp., 6 figs. Characteristic curves of Mazda street series lamp.

LIGHTNING PROTECTION

4000-Volt Circuits. Lightning Protection of 4000-volt lines, Thomas Commerford Martin. Elec. World, vol. 76, no. 20, Nov. 13, 1920, pp. 973–977 5 figs. Experimental investigation showed that density of lightning arresters on an electrical distribution system is far more important than type of arrester.

Studies in Lightning Protection on 4000-Volt Circuits—II, D.W. Roper. Jl. Am. Inst. Elec. Engrs., vol. 39, no. 11, Nov. 1920, pp. 960–975, 20 figs. Factors which affect lightning-arrester performance. Curves showing relative merits of various types of lightning arresters.

Spark Gaps. Lightning Arrester Spark Gaps—II, Chester T. Allcutt. Jl. Am. Inst. Elec. Engrs., vol. 39, no. 11, Nov. 1920, pp. 939–943, 12 figs. Data giving discharge characteristics of commercial type of impulse gap under different conditions. Factors that determine degree of protection afforded by lightning-arrester spark gap. Definition of "protection factor" and curves giving protection factor of certain types of gap.

Tests. Life and Performance Tests of O F Lightning Arresters, N. A. Lougee. Jl. Am. Inst. Elec. Engrs., vol. 39, no. 11, Nov. 1920, pp. 944–948, 5 figs. Performed at laboratories of General Electric Co.

LIME

Manufacture. The Manufacture of Lime for Chemical and Metallurgical Purposes—III, Richard K. Meade. Chem. & Metallurgical Eng., vol. 23, no. 19, Nov. 10, 1920, pp. 929–933, 3 figs. Methods of heating rotary kilns. Description and comparison of pulverized coal and producer gas installations. Boilers in series with kiln. Power consumption. Cost data.

LOCOMOTIVE BOILERS

Welding Flue Points to Boiler Tubes. Welding Flue Points to Boiler Tubes, Charles W. Geiger. Welding Engr., vol. 5, no. 10, Oct. 1920, pp. 44–46, 5 figs. Method developed by Charles S. Coleman of Santa Fe Railroad Co.

LOCOMOTIVES

Boosters. Operating Tests of a Pacific Type Booster Locomotive. Ry. Age, vol. 69, no. 17, Oct. 22, 1920, pp. 699–702, 6 figs. Additional tractive effort of booster has increased tonnage rating for division on New York Central.

Cylinder Parts. Cast Iron for Locomotive-Cylinder Parts, C. H. Strand. Technologic Papers, Bur. of Standards, no. 172, Sept. 11, 1920, 25 pp., 10 figs. Records of investigation of mechanical, chemical and metallographic properties of packing rings of various service mileages, and also of arbitration test bars, chill test blocks, and miscellaneous samples from various makers. It is concluded that existing specifications are insufficiently rigid as to requirements for mechanical tests and specification is proposed with revisions in accordance with results of these tests.

Electric. See ELECTRIC LOCOMOTIVES.

Lubrication of. Lubricator Locomotive Gears (Schmiergefässe am Lokomotiv-Triebwerk), H. Bauer. Verkehrstechnik, vol. 37, no. 21, July 25, 1920, pp. 298–299, 1 fig. Automatic lubricating device called Mobil, which has been used for a number of years for works railway locomotives and is now being used for trunk-line locomotives of German National Ry. Administration.

Mountain Type. Mountain Type Locomotives for the New Haven. Ry. Mech. Engr., vol. 94, no. 11, Nov. 1920, pp. 685–688, 8 figs. Equipment includes feedwater heaters and provision for future application of booster.

No-Load Arrangements. No-Load Arrangements on Locomotives (Leerlaufeinrichtungen an Lokomotiven), F. Meineke. Zeit. des Vereines deutscher Ingenieure, vol. 64, no. 39, Sept. 25, 1920, pp. 784–788, 25 figs. Describes typical constructions of air inlet valves, by-pass valves, etc., but states that there is no construction type adaptable to all cases. Aspects governing selection of suitable devices.

Oil-Burning. English Railways Experiment with Fuel Oil. Ry. Mech. Engr., vol. 94, no. 11, Nov. 1920, pp. 692–696. Description of Scarab fuel oil burning apparatus tested on London and Northwestern Ry.

Oil Burning on Locomotives. Ry. Engr., vol. 41, no. 489, Oct. 1920, pp. 414–418, 7 figs. Tests on London & Northwestern Railway with locomotive of "Precursor" class, equipped with Scarab oil burning apparatus.

Pennsylvania R. R. 2-10-0-Type Locomotive; Pennsylvania Railroad. Eng., vol. 110, nos. 2860 and 2861, Oct. 22 and 29, 1920, pp. 538–539, 23 figs., partly on supp. plates, and 586–587, 28 figs. Characteristics: Total weight in working order, 371,800 lbs.; driving wheels, diameter, 62 in.; cylinders, 30½ in x 32 in.; boiler pressure, 250 lb. per sq. in.; total heating surface, 4334 sq. ft.; superheater surface, 1478.9 sq. ft. (To be continued.)

Repair Shops. Large Shop Marks Development of Western Road. Ry. Age, vol. 69, no. 17, Oct. 22, 1920, pp. 687–690, 6 figs. Locomotive repair shops of Union Pacific Railroad at Cheyenne, Wyo.

Locomotive Repair Shop Organization and Methods. Ry. Engr., vol. 41, no. 489, Oct. 1920, pp. 410–412. Best method of obtaining maximum output, consistent with good work, from locomotive repair shops.

Wheel Balancing. Calculation of the Counterbalances in Locomotive Driving Wheels (Berechnung der Gegengewichte in Lokomotiv-Triebrädern), H. Igel. Organ für die Fortschritte des Eisenbahnwesens, vol. 57, no. 15, Aug. 1, 1920, pp. 153–156, 15 figs. Gives calculations for different types of locomotives.

Locomotive Wheel Balancing Machine. Ry. Mech. Engr., vol. 94, no. 11, Nov. 1920, pp. 719–720, 5 figs. Device used in British railroad shops tests wheels by rotating them in spring supported bearings.

M

MACHINE GUNS

Pocket Types. A Pocket Machine Gun, E. C. Crossman. Sci. Am., vol. 123, no. 16, Oct. 16, 1920, pp. 405–413–414, 4 figs. Types of pocket machine gun magazines and how gun is used by New York Police Department.

MACHINE-TOOL INDUSTRY

Germany. The German Machine Tool Industry. Machy. (N.Y.), vol. 27, no. 3, Nov. 1920, p. 232. It is reported that German manufacturers are no longer able to compute with prices on world's market.

The German Machine-Tool Industry Today. Am. Mach., vol. 53, no. 20, Nov. 11, 1920, pp. 923–924. Depression ascribed to overstretching prices.

Sweden. The Swedish Machine Tool Industry, S. E. Osmar. Mach. (N.Y.), vol. 27, no. 3, Nov. 1920, p. 227. Industry is described as very dull at present,a nd it is said that there is not immediate prospect for improvement.

MACHINE TOOLS

Developments. Recent Machine Tool Developments—XVI, Joseph Horner. Eng., vol. 110, no. 2859, Oct. 15, 1920, pp. 494–498, 16 figs. Milling machines.

Frames. A New Stiffening Construction for Machine Tool Frames (Neue Versteifungsbauart für Werkzeugmaschinenbetten), Ernst Peters. Werkstattstechnik, vol. 14, no. 16, Aug. 15, 1920, pp. 441–442, 5 figs. According to new method, frame of machine tool is provided with diagonal stiffening ribs in place of the rectangular ribs heretofore in use, in order to increase the accuracy of work and resistance against high stresses.

Plants. Service Department in a Machine Tool Plant. Machy. (N.Y.), vol. 27, no. 3, Nov. 1920, pp. 261–263, 3 figs. Outline of purpose, organization, equipment and methods of service department of Heald Machine Co., Worcester, Mass.

Regulating Motors. Shortening of Working Period and Reduction of Power Consumption through Regulating Motors (Abkürzung der Arbeitzeit und Verminderung des Kraftbedarfs durch Reguliermotoren), O. Pollok. Betrieb, vol. 2, no. 14, Aug. 1920, pp. 341–347, 1 fig. It is shown that machine tools with regulating motors prevent the lower outputs of all mechanically graded machines and, by control of the speeds, effect considerably higher outputs; a very great saving in power is effected by simplification of drive through the regulating motor. Recommendations for standards.

Safety Standards. Safety Standards of the Industrial Board. Commonwealth of Pennsylvania, Dept. of Labor & Industry, vol. 1, no. 5, 7 pp. Rules to safeguard workers in industries in which machine tools are used.

Speed Steps, Standardization of. Standardization of Speed Steps in Machine Tool Construction (Vereinheitlichung der Grösse des Stufensprunges im Werkzeugmaschinenbau), Ernest J. Wild. Der praktische Maschinen-Konstrukteur, vol. 53, no. 36, Sept. 9, 1920, pp. 155–157. Values are developed based on assumption that maximum cutting speed in practically all theoretical working diameters is the same.

MAGNETIC TESTING

Defectoscope. New Magnetic Testing Apparatus. Iron Age, vol. 106, no. 18, Oct. 28, 1920, pp. 1125–1128, 7 figs. Defectoscope, a device for magnetic testing of steel.

MALLEABLE CASTINGS

Manufacture in Electric Furnace. Malleable Made by Triplex Process, H. A. Schwartz. Foundry, vol. 48, no. 357, Oct. 15, 1920, pp. 815–817 and 825, 4 figs. Patented process involving use of cupola, side-blow converter and electric furnace. Details of operation and metallurgical reactions are explained. Paper read before Am. Foundrymen's Assn.

MARINE ENGINES

See DIESEL ENGINES, Marine.

MARKETS

Terminal, New York City. $75,000,000 Terminal Market Planned for New York. Manufacturers Rec., vol. 78, no. 19, Nov. 4, 1920, pp. 151–152, 1 fig. Municipally owned system expected to eliminate waste and solve many problems of producer and bring cheaper food to consumer.

MEASURING INSTRUMENTS

Developments. Precision Instruments in Engineering Works (Le misure di precisione nelle officiene meccaniche), Vernon I. N. Williams. Revista d'Ottica e Meccanica di Precisione, vol. 1, nos. 7–8, Mar.–Apr. 1920, pp. 129–145, 34 figs. Survey of developments throughout the world.

Phosphoroscope. A Special Form of Phosphoroscope, W. S. Andrews. Gen. Elec. Rev., vol. 23, no. 10, Oct. 1920, pp. 856–857, 6 figs. Type developed by writer for visual observation of phosphorescent and fluorescent light emitted by various compounds when excited by ultra-violet light.

METAL INDUSTRY

German. The Metal Supply Problem in German—I, C. A. Heise. Iron Age, vol. 106, no. 20, Nov. 11, 1920, pp. 1295–1297. How war shortages were met by substitutions. Effect of latter on present and future consumption of copper and tin.

METALLURGY

Developments in. Recent Progress in the Control of Metallurgical Products (Les progrès récents des méthodes de controle des produits métallurgiques), Leon Guillet. Génie Civil, vol. 77, no. 16, Oct. 16, 1920, pp. 313–316, 7 figs. Industrial uses of equilibrium diagrams of alloys (Concluded).

METALS

Crystal Growth. Crystal Growth and Recrystallisation in Metals, H. C. H. Carpenter and Miss C. F. Elam. Eng., vol. 110, no. 2858, Oct. 8, 1920, pp. 486–490, 16 figs. Review of theories of crystal growth in light of evidence obtained in experimental research. (Concluded.) (Abstract.) Paper read before Inst. of Metal.

Rust Prevention. Preventing Rust at High Temperatures, Robert June. Sci. Am., vol. 123, no. 16, Oct. 16, 1920, pp. 404 and 412–413, 4 figs. Aluminum-coated metals that will go to melting point without formation of scale.

Supra-Conduction of. The "Supra-Conducting Condition" of Metals (Der "supraleitende Zustand" von Metallen), C. A. Crommelin. Physikalische Zeitschrift, vol. 21, nos. 10, 11 and 12, May 15, June 1 and 15, 1920, pp. 274–280, 300–304 and 331–336, 11 figs. Discussion of a series of investigations on the resistance of metals carried out in Prof. Kamerlingh Onnes' cryogenic laboratory of Leiden at temperatures which can be reached solely with liquid helium, and which led to the discovery of the so-called supra-conducting condition of different metals. Address delivered before Physical Soc. at Leiden in Feb. 1919.

Thermostatic. Thermostatic Metal. Automotive Industries, vol. 43, no. 17, Oct. 21, 1920, p. 819. New thermostatic metal developed by H. A. Wilson Co., and being placed on market under trade name "Wilco."

METRIC SYSTEM

Arguments Against Adoption in U. S. Anti-Metric Resolutions. Am. Mach., vol. 53, no. 20, Nov. 11, 1920, pp. 916–917. Resolutions against compulsory adoption of metric system in U. S., passed by Automotive Wood Wheel Manufacturers' Assn., Hickory Products Assn., New Jersey Lumbermen's Assn., Kentucky Manufacturers' Assn., Am. Assn. of Engrs., Hydraulic Soc., Compressed Air Soc. and many other associations and Chambers of Commerce.

The Metric System and International Trade, Harry Alcock. Nature (Lond.), vol. 106, no. 2658, Oct. 7, 1920, pp. 169–170. Comment on Report on Compulsory Adoption of the Metric System in the United Kingdom, submitted by metric committee appointed by Conjoint Board of British Scientific Societies. Recommendations include plea for continued use of British units by Department of State.

The English and the Metric Measuring System—A Comparison, C. C. Stutz. Am. Mach., vol. 53, no. 20, Nov. 11, 1920, pp. 911–913. It is held that metric units are either too large or too small for every day requirements in industry.

MILLING

Circular Segments. Milling Fixture for Circular Segments. Machy. (N.Y.), vol. 27, no. 3, Nov. 1920, pp. 229–230, 3 figs. Features of construction of hinged milling fixtures designed for use in performing gang milling operations in circular segments.

Continuous vs. Station. Continuous versus Station Milling. Machy. (Lond.), vol 17, no. 422, Oct. 28, 1920, pp. 106–108, 4 figs. Comparison of results that are obtained by both methods of milling on identical work when using similar machines in interchangeable manufacture.

MILLING CUTTERS

Manufacture. Making "Curvex" Milling Cutters. Machy. (N.Y.), vol. 27, no. 3, Nov. 1920, pp. 250–258, 17 figs. Methods and equipment employed by Pratt & Whitney Co., Hartford, Conn., in manufacture of formed milling cutters with helical flutes.

MILLING MACHINES

Locomotive Parts. Milling Machines for Crown-Bar Frames of the A. Borsig Locomotive Factory (Barrenrahmenfräsmaschinen der Lokomotivfabrik A. Borsig.) Werkstattstechnik, vol. 14, no. 14, July 15, 1920, pp. 390–395, 16 figs. Details of special machine designed by engineer of Schiess

ENGINEERING INDEX (Continued)

Machine Factory, Ltd., Düsseldorf, in the Borsig works. Specifications: max. length of frames to be cut, 11,000 mm.; max. height, 900 mm.; diam. of cutter spindle, 90 mm.; speed of cutter spindle, 320 r.p.m.; speed of motor, 1250 r.p.m.; etc. Machines are constructed in two types, with two and with three uprights, the latter serving for the simultaneous machining of two locomotive crown-bar frames.

MINE TIMBERING

Preservative Treatment. Saving Mine Timbers from Decay. Forest Products Laboratory, Technical Notes, Oct. 15, 1920, no. 110, 1 p. Three preservatives have been found suitable for mine work: coal-tar creosote, zinc chloride and sodium fluoride.

MINING INDUSTRY

Norway. The Mining and Metallurgical Industry of Norway. Matthew R. Blish. Eng. and Min. Jl., vol. 110, no. 18, Oct. 30, 1920, pp. 856–858. Brief review of resources and past and present production. Iron still most important metal, with copper and molybdenum of secondary interest. Development dependent upon increased application of electric power.

MOLDING MACHINES

European Types. European Equipment Progressive, H. Cole Estep. Foundry, vol. 48, no. 357, Oct. 15, 1920, pp. 818–825, 21 figs. Most of molding-machine manufacturers of Europe are found in Great Britain, France, and Germany. Although war exerted depressing effect upon new molding machines, it served to develop to high efficiency those already in service. Excellence is shown in smaller types. Paper read before Am. Foundrymen's Assn.

MOTOR BUSES

Street Cars vs. Bridgeport Tries the Jitney. Aera, vol. 9, no. 3, Oct. 1920, pp. 239–253, 6 figs. Experiment of eight weeks without trolleys is said to have shown motor bus incapable of furnishing satisfactory transportation.

MOTOR PLOWS

British. Fowler Ploughing Machinery. Eng., vol. 110, no. 2859, Oct. 15, 1920, pp. 507–508 and 510, 3 figs. Machines built by John Fowler & Co., Ltd. Double steam engine set rated at 8 hp. nominal is used.

Internal Combustion Cable Ploughing Engine. Eng., vol. 100, no. 2859, Oct. 15, 1920, pp. 506–507, 9 figs. Weight is $3^1/_4$ tons for each engine with fuel and spuds, and power developed is 32 b.hp. Four-cylinder Dorman engine arranged to burn paraffin is used.

MOTOR TRUCKS

British. $7^1/_2$-Ton Six-Wheel Commerical Vehicles. Eng., vol. 110, no. 2859, Oct. 15, 1920, pp. 518–520, 5 figs. Engine is of four-cylinder type and develops 47 b.hp. at 1000 r.p.m. It drives through Ferodo-lined cone clutch with aluminium male member.

Olympia Show. Exhibits at the Commercial Motor Exhibition. Eng., vol. 110, no. 2860, Oct. 22, 1920, pp. 535–536 and 542, 6 figs. Leading features of exhibit at Olympia.

The Commercial Motor Exhibition—I. Engr., vol. 130, no. 3382, Oct. 22, 1920, pp. 400–402 and 404, 13 figs. Details of principal exhibits.

The Commercial Motor Exhibition. Eng., vol. 110, no. 2860, Oct. 22, 1920, pp. 546–549. Editorial comments on progress as shown by exhibits at Olympia show.

Worm Drives. Tests on Rear-Axle Worm Drives for Trucks, Kalman Heindlhofer. Mech. Eng., vol. 42, no. 11, Nov. 1920, pp. 613–615, 10 figs. Determination of efficiencies under load variations. Efficiency curves showing results with four sets of gears in mesh are included. Effect of oil temperature in worm thrust bearing, on efficiency of drive is given, high efficiencies being derived at higher oil temperatures.

MOTORSHIPS

European Built. Motorship Building in Europe. Marine Eng., vol. 25, no. 11, Nov. 1920, pp. 921–923, 3 figs. Particulars of six new 14,000-ton motor vessels.

Standardization. Standardization of Motor Ships. Times Eng. Supp., vol. 16, no. 552, Oct. 1920, p. 304. Growth of policy.

N

NICKEL STEEL

Classification. The Anomaly of the Nickel-Steels, Charles Edouard Guillaume. Physical Soc. of London, Proc., vol. 32, part 5, Aug. 15, 1920, pp. 374–404, 15 figs. Classification by means of magnetic properties, changes of volume, progressive and transitory variations. Fifth Guthrie lecture.

NOZZLES

Calibration. Calibration of Nozzles for Measurement of Air Flowing into a Vacuum, Wm. L. De Baufre. Mech. Eng., vol. 42, no. 11, Nov. 1920, pp. 607–609 and p. 650, 6 figs. Investigation of flow of elastic fluid through nozzles having well-rounded entrances, effects of frictional resistance and of moisture in atmosphere when fluid is atmospheric air being taken into account. It is shown that rate of flow of dry air decreased with increases of moisture. Investigation was conducted at U. S. Naval Engineering Experiment Station, Annapolis, Md.

Tests. Investigations of Diffusers (Ueber Diffusoruntersuchungen). Der praktische Maschinen-Konstruckteur, vol. 53, no. 31, Aug. 5, 1920, pp. 280–282, 1 fig. Abstract of report on results of measurements on a steam diffuser carried out in the machine-construction laboratory of the Charlottenburg Technical Academy, tests being carried out according to two aspects, namely, variable condition of steam with a given nozzle, and different nozzles with corresponding initial condition.

O

OIL

Crude. Experimental Determination of Evaporation Losses from Crude Oil during Piping and Storage on Oil Leases, A. R. Elliott. Reports of Investigations, Bur. of Mines, Dept. of Interior, serial no. 2169, Oct. 1920, 3 pp. Tests made to determine quantities and values lost.

OIL ENGINES

British. Some Lincolnshire Oil-Engines, F. H. Livens. Jl. Instn. Mech. Engrs., no. 6, Oct. 1920, pp. 673–697 and (discussion) pp. 697–707, 18 figs. Survey of most important methods of vaporization and ignition adopted and of increasing economy effected from time to time.

Hot-Bulb. 40-B.HP. Marine Two-Cycle Hot-Bulb Oil Engine. Eng., vol. 110, no. 2861, Oct. 29, 1920, pp. 568–569, 26 figs. partly on supp. plate. Engine is fitted with reversing gear and with bilge circulating air and lubricating pumps. It has 7 in. cylinders by 8 in. stroke and runs at 400 r.p.m. developing 40 b.hp. at that speed. Engine is manufactured by Norris, Henty & Gardners, Ltd., London.

Velocity of Fuel Injection. Determination of the Velocity of Solid Fuel Injection, David Turcott Gas Engine, vol. 22, no. 11, Nov. 1920, pp. 318–319. Experimental study. Velocity of injection in two-stroke cycle 30 hp. oil engines varied from 103 to 109 ft. per sec. with load from 0 to 100 per cent.

[See also HEAVY-OIL ENGINES.]

OIL FUEL

Economics. Fuel Oil as a Means to Increased Capacity, C. C. Lance. Ry. Mech. Engr., vol. 94, no. 11, Nov. 1920, pp. 723–724. Critical boiler plant condition relieved and efficiency improved by use of fuel oil in place of coal.

Measurement Policy. A National Liquid Fuel Policy, R. S. McBride. Power, vol. 52, no. 17, Oct. 26, 1920, pp. 665–669, 2 figs. Possibilities of producing substitutes in liquid fuel supply. Best method for distributing available supplies among various classes of users when total demand exceeds available supplies.

OIL SHALES

Commercial Retorting. Commercial Retorting of Oil Shales, Louis Simpson. Chem. & Metallurgical Eng., vol. 23, no. 16, Oct. 20, 1920, pp. 789–791. Applicability of methods used in Scotland to American oil shales.

Indiana. Oil Shales of Indiana, John R. Reeves. Eng. & Min. Jl., vol. 110, no. 20, Nov. 13, 1920, pp. 954–955. Advantages of location and homogeneous character of raw material warrant expectation of commercial possibilities when experimental data determine satisfactory method of recovery. Results of dry and steam distillation tests.

OIL WELLS

Shutting Off Water. Shutting Off Water in Oil Wells. Petroleum World, vol. 17, no. 242, Nov. 1920, pp. 448–450, 2 figs. Patented process for shutting off water in oil wells by freezing limited area surrounding well casing.

ORES

Classifier. The Mitchell Electric Vibrating Screen, Chas. W. Stimpson. Monthly Jl. Utah Soc. Engrs., vol. 6, no. 4, Sept. 1920, pp. 51–54, 10 figs. partly on 2 supp. plates. Moving force is electric vibrator unit, applied from beneath screen cloth.

OVENS

Core Baking. Core Baking in Electrically Heated Ovens, Jesse L. Jones. Metal Industry (N. Y.), vol. 18, no. 10, Oct. 1920, pp. 450–451, 2 figs. New electric core oven developed by Westinghouse Electric & Mfg. Co. Records of its operation. Paper read before Am. Foundrymen's Assn.

OXY-ACETYLENE CUTTING

Cast Iron. Cutting Cast Iron with the Oxy-Acetylene Flame, Alfred S. Kinsey. Acetylene Jl., vol. 22, no. 5, Nov. 1920, pp. 264–269 and p. 272, 4 figs. Method of procedure. Paper read before Am. Foundryman's Assn.

OXY-ACETYLENE WELDING

Trade School for. An Acetylene Welding and Cutting Institute. Sheet Metal Worker, vol. 11, no. 11, Oct. 29, 1920, pp. 307–310, 4 figs. School established and conducted by equipment manufacturer where sheet metal mechanics and others are given instruction in these branches of industry.

[See also AUTOGENOUS WELDING.]

OXYGEN

Production in Germany. Oxygen and Nitrogen Production in Germany, R. Linde. Eng. Progress, vol. 1, no. 10, Oct. 1920, pp. 297–300, 5 figs. Low temperature processes. Modern installations for production of nitrogen and oxygen. Largest installations of world. Practical use of oxygen and nitrogen.

P

PAINTING

Spray. The Vortex Painter. Commercial America, vol. 17, no. 5, Nov. 1920, p. 51. Nozzle has two openings, a central opening for paint and an annular opening around center from which air is discharged as veritable blast under pressure approximating 60 lb. per sq. in.

PATTERNS

Wheels. Wheel Patterns. Machy. (Lond.), vol. 17, no. 421, Oct. 21, 1920, pp. 91–93, 7 figs. Making of patterns for webbed and flanged wheels as well as for wheels with arms. Methods used for molding wheels without complete patterns.

PETROLEUM

Production. Liquid Fuels—Wanted: A National Policy, R. S. McBride. Eng. and Min. Jl., vol. 110, no. 17, Oct. 23, 1920, pp. 823–825, 1 fig. It is urged that consideration be given to need for securing maximum oil production, reduction of consumption, or finding of new sources, to obtaining of substitutes and to adequate distribution of available supplies.

[See also OIL, Crude.]

PIPE, CONCRETE

Joint for. New Type of Concrete Pipe Joint. Eng. World, vol. 17, no. 5, Nov. 1920, pp. 360–361. Use of machined casting for bell and spigot rings.

PLATINUM

Colombia, S. A. Platinum in Colombia, J. Ovalle. Eng. & Min. Jl., vol. 110, no. 19, Nov. 6, 1920, pp. 907–908. Foreign capital to realize future possibilities of industry. Output of Choco region increasing. That of Urals passed its peak before war. Ordinary methods of production employed.

PNEUMATIC MAIL TUBES

See COMPRESSED AIR, Pneumatic Mail Despatch.

POLES

Preservative Treatment. Preservative Treatment of Wood Poles, R. V. Achatz. Purdue University, Publications Eng. Dept., vol. 4, no. 2, June 1920, 54 pp., 18 figs. Practices in Indiana. Specfications for preservatives adopted by Am. Ry. Eng. Assn., Nat. Elec. Light Assn. and U. S. Shipping Board Emergency Fleet Corporation.

The Kyanizing of Wooden Poles (Beitrag zur Kyanisierung von Holzmasten), Robert Nowotny. Elektrotechnik u. Maschinenbau, vol. 38, no. 22, May 30, 1920, pp. 249–251, 2 figs. Results of experiments on the absorption of liquids in the kyanizing process.

PORTS

Antwerp. The Port of Antwerp, H. E. Cooper Newham and Clifford Atkinson. Shipping, vol. 12, no. 4, Oct. 25, 1920, pp. 19–27 and 32, 6 figs. Cargo handling machinery and equipment.

Layout of. What the Government is Doing to Help Port Layout, F. T. Chambers. Eng. News-Rec., vol. 85, no. 18, Oct. 28, 1920, pp. 850–851. Shipping act instructs U. S. Shipping Board and Secretary of War to promote port development and transportation facilities in connection therewith. Extent to which this instruction has been carried out is outlined in article. (Abstract.) Paper read before Am. Assn. of Port Authorities.

POWER FACTOR

Improvement of. The Power Factor Problem (Zur Leistungsfaktorfrage), H. Buchholz. Elektrische Kraftbetriebe u. Bahnen, vol. 18, no. 24, Aug. 24, 1920, pp. 201–202, 2 figs. Discussion of measures adopted in Germany, France and especially America for increasing power factor in three-phase current. Notes on installation of synchronous in place of asynchronous motors, phase displacers, tariff regulations; enlightenment of consumers concerning phase displacement through an example from commercial practice.

POWER PLANTS

Automatic Regulation. Automatic Hydraulically Operated Regulating System Iron Age, vol. 106, no. 19, Nov. 4, 1920, pp. 1185–1187, 4 figs. Area system for automatic regulation of steam, gas, moisture, temperature, electric current, etc., in use in various industries in Sweden, and being introduced in U. S. by American Galco, Inc., New York City.

POWER TRANSMISSION

Carey Oil System. The Carey Oil Transmission System. Engr., vol. 130, no. 3377, Sept. 17, 1920, p. 284, 2 figs. Machines for transmitting power by means of oil under pressure. Two pumps are used which have balls instead of disks as pistons. Balls are giving reciprocating motion in regard to cylinders by being rotated within eccentric rings.

PRESSWORK

Methods. Press Work in an Electric Motor Plant—I, Fred R. Daniels. Machy. (N.Y.), vol. 27, no. 3, Nov. 1920, pp. 264–269, 15 figs. Methods used in power press department of Gen. Elec. Co., Lynn, Mass.

PROSPECTING

Desert. Desert Prospecting, Leroy A. Palmer. Eng. and Min. Jl., vol. 110, no. 18, Oct. 30, 1920,

ENGINEERING INDEX (Continued)

pp. 850-853, 4 figs. Conditions characteristic of arid regions. Topographic features frequently deceptive. Principles to be observed in investigations of dry placers. Occurrence of water.

PUBLIC UTILITIES

Rate of Return. Utility Regulation and Rate of Return, Cecil F. Elmes. Elec. Ry. Jl., vol. 56, no. 16, Oct. 16, 1920, pp. 760-764. It is argued that dual standard of commerce regulation which affects utilities, but exempts other industries, has no justification on historical grounds or as matter of public policy. Effect on financing of utilities analyzed. (Abstract.) Paper read before Am. Elec. Ry. Assn.

PUBLIC WORKS

National Department of. The National Department of Public Works Situation. Eng. News-Rec., vol. 85, no. 18, Oct. 28, 1920, pp. 834-835. Report of M. O. Leighton to Engineering Council states that moral support is needed now to finish legislative program. Engineers' Corps will control unless civilians act, report says.

PULLEYS

Cone. Machining Cone Pulleys, Ralph E. Flanders. Machy. (Lond.), vol. 17, no. 419, Oct. 7, 1920, pp. 11-12, 4 figs. Tooling equipment and methods employed in the quantity production of three and four-step cone pulleys.

PUMPING STATIONS

Gas-Engine-Driven. Gas-Engine-Driven Pumping Plant at the Tilbury Docks. Eng., vol. 110, no. 2860, Oct. 22, 1920, pp. 532-534, 5 figs. Installation for pumping out dry docks for Port of London Authority.

Pump Selection. Well Tests—The Basis for Pump Selection, George M. Shepard. Mun. & County Eng., vol. 59, no. 4, Oct. 1920, pp. 137-138, 1 fig. Diagram showing results of tests on 12-in. well, 380 ft. deep.

PUMPS, CENTRIFUGAL

Tests. Motor-Driven Pumps Develop High Efficiency. Eng. World, vol. 17, no. 5, Nov. 1920, pp. 358-360, 3 figs. Tests on centrifugal pumps direct connected to synchronous motors at McCarren pumping station, Water Department of City of St. Paul, Minn.

R

RADIO COMMUNICATION

Alexanderson's System. Transoceanic Radio Communication, E. F. W. Alexanderson. Gen. Elec. Rev., vol. 23, no. 10, Oct. 1920, pp. 794-803, 12 figs. Description of Alexanderson's system of telegraphic and telephonic radio.

The Alexanderson System for Radio Communication, Elmer E. Bucher. Gen. Elec. Rev., vol. 23, no. 10, Oct. 1920, pp. 813-839, 41 figs. Description is devoted principally to 200-kw. set.

[See also RADIOTELEGRAPHY; RADIOTELEPHONY.]

RADIOTELEGRAPHY

Antennae. A Rule for Antenna Models (Ein Satz über Modelle von Antennen), Max Abraham. Jahrbuch Zeit. für Telegraphie u. Telephonie, vol. 16, no. 1, July 1920, pp. 67-70. Writer evolves a law which, it is claimed, can be used for the qualitative and eventually for quantitative determination of the earth resistance of antennæ.

Abstractive and Selective Properties of Radio Antenna Circuits, Edward Bennett. Jl. Am. Inst. Elec. Engrs., vol. 39, no. 11, Nov. 1920, pp. 995-1004, 7 figs. Consideration of properties of simple series antenna circuit with object of determining circuit proportions and frequencies which will make circuit most highly responsive to correspondent's signal and unresponsive to interference sources.

Coils vs. Antennae. The Use of Coils in Place of Antennæ in Radiotelegraphic Reception (Ueber die Verwendung von Spulen an Stelle von Antennen beim Empfang in der drahtlosen Telegraphie), Herbert Hoffmann. Jahrbuch Zeit. für Telegraphie u. Telephonie, vol. 16, no. 1, July 1920, pp. 31-66, 22 figs. Points out advantages of a receiving apparatus without antennæ, describes qualities of coils, and gives results of experimental tests of the most feasible connections. Recommendations for use of coils in special cases and for radiotelephony. Report from laboratory of the Torpedo Inspection at Kiel.

High-Speed. Service Tests and Experiences with Wireless High-Speed Telegraph (Ueber Betriebsversuche und Erfahrungen mit drahtloser Schnelltelegraphie), Fritz Banneitz. Telegraphen- u. Fernsprech-Technik, vol. 9, no. 5-6 Aug. 1920, pp. 90-93, 5 figs. Describes arrangement adopted in connection with installation of a new high-speed network by the Nat. Telegraph Administration; and gives results of high-speed tests with the Wheatstone system carried out by the Wireless Service Bur., Berlin, between Berlin and Stettin and between Berlin and Königsberg, from which it is concluded that, with use of described apparatus, a serviceable high-speed connection can be maintained.

Research. Recent Experimental Work in Radiotelegraphy (Neuere Arbeiten aus dem Gebiete der Funkentelegraphie), F. Kiebitz. Telegraphen- u. Fernsprech-Technik, vol. 9, no. 5-6, Aug. 1920, pp. 88-90, 2 figs. Notes on investigations of antennæ and earth connections; freedom from disturbances of the different receiving types in connection with damped oscillations; reception results with the different systems of undamped wireless telegraphy with regard to the constancy of the periods; wireless telephony; measuring methods and investigations of coils; reception by means of writing apparatus; etc. Preliminary report from the Telegraph Testing Bur.

Signaling. A New Arc Method for Continuous Waves. Wireless Age, vol. 8, no. 2, Nov. 1920, p. 19, 3 figs. Method of signaling with arc transmitter.

RADIOTELEPHONY

Receivers. Duplex Radiophone Receiver on U.S.S. George Washington, Harold H. Beverage. Gen. Elec. Rev., vol. 23, no. 10, Oct. 1920, pp. 807-812, 5 figs. In arranging for duplex communication between George Washington and land stations, one of major difficulties encountered was prevention of each receiver from being affected by powerful interference of its own transmitter. Problem was solved by separating transmitting and receiving stations distance of four miles. How this scheme worked out for land stations, was modified on board George Washington is described.

Transmitters. Radiophone Transmitter on the U.S.S. George Washington, John H. Payne. Gen. Elec. Rev., vol. 23, no. 10, Oct. 1920, pp. 804-806, 2 figs. With chart showing names and positions of ships which reported hearing radiophone messages from U.S.S. George Washington.

RAILS

Creep of. Rail Creep. Ry. Engr., vol. 41, no. 489, Oct. 1920, pp. 412-413. Summary of views of prominent engineers on bodily movement of rails in longitudinal direction.

Electric Welding of. See ELECTRIC WELDING, Rails.

Rolling of. Steel Rails from Sink-Head and Ordinary Rail Ingots, George K. Burgess. Chem. & Metallurgical Eng., vol. 23, nos. 19 and 20, Nov. 10 and 17, 1920, pp. 921-925 and 969-975, 8 figs. Nov 10: Experimental investigations of Pennsylvania Railway; Nov. 17: Sink-head ingots are shown to give much more uniform metal than common American types.

RAILWAY CONSTRUCTION

Earth Shrinkage in Fills. Density Tests of Earth Shrinkage in Railway Fills. Eng. News-Rec., vol. 85, no. 17, Oct. 21, 1920, pp. 782-783, 1 fig. Density tests of earth samples made by valuation department of Chicago, Burlington & Quincy Railroad. Density was found to vary according to depth in original excavation.

Shrinkage and Swell of Materials in Railway Fill. Eng. World, vol. 17, no. 5, Nov. 1920, pp. 362-363. Actual measurement taken of many fills. Rock swells, earth shrinks. Carriers' report to Interstate Commerce Commission.

RAILWAY ELECTRIFICATION

Belgium. Railway Electrification in Belgium (Elektrification des chemins de fer de l'état Belge), A. Tétrel. L'Électricien, vol. 51, no. 1261, Oct. 1, 1920, pp. 409-413, 1 fig. Proposed plan.

British. The Electrification of British Railways, Albert H. Bridge. Elec. Rev. (Chicago), vol. 77, no. 18, Oct. 30, 1920, pp. 685-686. Points considered and recommendations made by government committee of engineering and railway experts.

The Electrification of Railways. Elecn., vol. 85, no. 2212, Oct. 8, 1920, p. 421; also editorial comment, pp. 412-413; and also in Ry. Engr. vol. 41, no. 490, Nov. 1920, pp. 453-454 and Tramway & Ry. World, vol. 48, no. 19, Oct. 14, 1920, pp. 226-227. Interim report of Committee appointed by British Ministry of Transport to inquire into certain questions connected with electrification of railways. Committee recommend that future standard system of working electric railways shall be direct current at 1500 volts, but existing 600- and 1200-volt railways may continue in use, their extension being subject to approval of Ministry. (Abstract.)

Japan. Electrifying Japan's State Railways, Ivan F. Baker. Trans-Pacific, vol. 3, no. 5, Nov. 1920, pp. 47-51, 8 figs. Account of progress made, with particular reference to recent projects involving electrification of over 400 miles. Also brief survey of railway electrification developments throughout the world.

RAILWAY OPERATION

Divisional Organization. Railway Operation and Maintenance under Divisional Organization, Alfred Price. Central Ry. Club, Official Proc., vol. 28, no. 3, May 1920, pp. 866-873 and (discussion) pp. 873-894, 1 fig. Scheme of organization of Canadian Pacific Railway.

Increasing Car Service. Increasing the Miles Per Car Per Day, A. G. Smart, J. Burnett, E. H. DeGroot, Jr., F. P. Roesch and A. F. Mercier. Ry. Age, vol. 69, no. 20, Nov. 12, 1920, pp. 824-828. Papers received in contest held by Railway Age on means for increasing the average miles per car per day.

Locomotive Schedules. Economical Operation of Railways (De la reduction du prix de revient dans l'exploitation des chemins de fer), Ulysse Lamalle. Revue universelle des Mines, vol. 7, no. 1, Oct. 1, 1920, pp. 1-45, 7 figs. Organization of service schedule for locomotives.

Supervision. The Problems of the Supervising Officers, Samuel O. Dunn. Ry. Mech. Engr., vol. 94, no. 11, Nov. 1920, pp. 689-691. Their duties and responsibilities under private railroad management; organization of foremen.

RAILWAY SHOPS

Brass Castings for. Heavy Brass Castings for Railroad Shops. Ry. Mech. Engr., vol. 94, no. 11, Nov. 1920, pp. 725-726, 2 figs. It is said important savings are possible by operating brass foundries in conjunction with railroad shops.

Car, N. Y. C. N. Y. C. Steel Car Shop at East Buffalo. Ry. Mech. Engr., vol. 94, no. 11, Nov. 1920, pp. 701-703, 7 figs. Capacity of building is 236 cars.

Tools. Tools from a Railroad Blacksmith Shop, Fred H. Colvin. Am. Mach., vol. 53, no. 18, Oct. 28, 1920, pp. 795-797, 10 figs. Methods of punching, shearing and forming metal.

RAILWAY TIES

Reinforced Concrete. Reinforced Concrete Sleepers—I. Indian Eng., vol. 68, no. 13, Sept. 25, 1920, pp. 179-182. Review of their requirements and their advantages.

Timber. Cross-Tie Forms and Rail Fastenings, with Special Reference to Treated Timbers, Hermann Von Schrenk. U. S. Dept. of Agriculture, Bur. of Forestry, Bull. no. 50, 1904, 71 pp. Possibilities of using substitutes for wood for railway ties are discussed, methods of cutting timber ties are surveyed, and modifications in them are recommended, and specifications and classification of ties are suggested.

RAILWAY TRACK

Catchpoints. The Relative Utility of Catchpoints and Buffer Stops. Ry. Gaz., vol. 33, no. 16, Oct. 15, 1920, pp. 510-514, 11 figs. Results of some Great Western experiments in connection with derailing efficiency of various types of catchpoints, and utility of buffer stops as compared with soft banks.

Materials. On the Question of Special Steels (Subject III for Discussion at the Ninth Congress of the International Railway Association), Mr. Sand. Bul. Int. Ry. Assn., vol. 2, no. 9, Sept. 1920, pp. 563-570. Report on the kinds of special steel used for tracks, in particular for rails, switches, single and double crossings, expansion devices at ends of bridges and other parts of track. Data are based on experiences of railways in various countries.

Standardizing Work. Methods of Standardizing Track Work, Earl Stimson. Official Proc. St. Louis Ry. Club. vol. 25, no. 5, Sept. 23, 1920, pp. 55-67. Experience of Baltimore & Ohio Railroad.

Ties. See RAILS; RAILWAY TIES.

Work Records. New System of Track Work Records on St. L.-S. F. Ry. Eng. News-Rec., vol. 85, no. 20, Nov. 11, 1920, pp. 949-952, 5 figs. Foremen report time and amount of work in detail classification. Figures extended to cover operating divisions.

RAILWAYS

China and the Orient. The Railways of the Orient, Donald F. McLeod. Eng. News-Rec., vol. 85, no. 20, Nov. 11, 1920, pp. 952-955, 2 figs. Rolling stock and construction of roadbed are chiefly of European types. Locomotives and dining and freight cars are mostly of American type.

Location of Industries on Rights-of-Way. Hazards Incident to the Location of Industries on Railroad Right-of-way. Ry. Rev., vol. 67, no. 19, Nov. 6, 1920, pp. 713-715, 1 fig. Discussion of relations between railroads and industries, nature of whose operations are conducive to fire hazard, and forms of agreements that should properly exist between such contracting parties. Paper presented at recent convention of Railway Fire Prevention Association at Baltimore, Md.

REFRIGERATING PLANTS

Ammonia Charge. Behavior of Ammonia in Refrigerating Plants, John H. Ryan. Power, vol. 52, no. 16, Oct. 19, 1920, pp. 613-614, 2 figs. How to find quantity of ammonia necessary to add to charge of running plant.

Electrically Operated. Electrical Refrigeration, C. J. Carlsen. Elec. Jl., vol. 17, no. 11, Nov. 1920, pp. 502-506, 7 figs. Progress in Chicago and suburbs.

Refrigerating Plant at Los Angeles Wholesale Terminal, C. W. Geiger. Power Plant Eng., vol. 24, no. 22, Nov. 15, 1920, pp. 1059-1061, 5 figs. Refrigerating machinery throughout is operated by electric motors, total of 340 hp. of electric motors operating 175 tons of refrigerating machinery.

RELAYS

Reverse-Power Type. Protective Relays-Reverse-Power Type, Victor H. Todd. Power, vol. 52, no. 18, Nov. 2, 1920, pp. 689-692, 10 figs. Conditions produced in system of parallel feeders when short-circuit occurs and types of reverse-power relays that will operate under these conditions. Both single-phase and polyphase relays are treated of.

RESEARCH

Aircraft. The Present Position of Aircraft Research and Contemplated Developments, E. L. Ellington. Flight, vol. 12, no. 44, Oct. 28, 1920, pp. 1130-1132; also in Engineering, vol. 110, nos. 2859 and 2860, Oct. 15 and 22, 1920, pp. 504-505 and 554-555. Directions in which British Air Ministry expect aircraft engines and accessories to develop, and steps they are taking to bring about developments they require. Paper read before Air Conference London, Oct. 13, 1920.

ENGINEERING INDEX (Continued)

Coördination of. Coördination of Research in Works and Laboratories, H. R. Constantine. Jl. Instn. Elec. Engrs. (Supp.), vol. 57, part 2, Oct. 1920, pp. 134–148 and (discussion) pp. 148–157. Scheme of coördination suggested.

Great Britain. Report of Third Conference of Research Organisations. Dept. of Sci. & Indus. Research, no. 3, May 14, 1920, 33 pp. Titles of paper read at conference were: Relations of Research Associations on Existing Institutions for Research; and Staffing of Research Association, Salaries and Superannuation.

Industrial. Scientific and Industrial Research. Times Eng. Supp., vol. 16, no. 552, Oct. 1920, pp. 301–302. Review of work done by Department of Scientific and Industrial Research during its five years of service.

Industrial, Canada. Science and Industry, J. C. Fields. Dominion of Canada, Bul. vol. 5, 1918, 11 pp. Significance of industrial research. Address delivered to Toronto Board of Trade.

The Need for Industrial Research in Canada, Frank D. Adams. Dominion of Canada, bul. no. 1, 1918, 8 pp. Successful applications of research in other countries are pointed out. Lines along which research should be undertaken in Canada are indicated.

Non-Ferrous Metallurgy. The Development of Non-Ferrous Metallurgical Research, Ernest A. Smith. Metal Industry (Lond.), vol. 17, no. 17, Oct. 22, 1920, pp. 327–331. Chairman's address before Sheffield Section of Institute of Metals.

RESERVOIRS

Dams for. See DAMS, Tilting.

RIVER TRAFFIC

Revival in U. S. The Revival of River Commerce, Particularly on the Mississippi River, Frank T. Hines. Jl. Engrs. Club. of St. Louis, vol. 5, no. 3, July-Aug.-Sept. 1920, pp. 13–20. Economics of river traffic. Importance of furthering present movement for its increase. Plea for liberarity from banks.

RIVERS

Snake River, Idaho. Distribution of Snake River Water During Greatest Drought. Eng. News-Rec., vol. 85, no. 20, Nov. 11, 1920, pp. 927–931, 7 figs. Continuous flow supersedes intermittent flashes. One man handles storage and natural flow like train dispatcher.

RIVETING

Electric Riveting Machine. A New Electric Riveting Machine (Eine neue elektrische Nietervärmungsmaschine). Autogene Metallbearbeitung, vol. 13, no. 14, July 15, 1920, pp. 154–157, 1 fig. Details of new machine constructed by German Welding Machine Factory Becker & Co., Berlin-Schöneberg, for the heating with alternating current of iron rivets of from 6 to 40 mm., which, it is believed will play an important role in large boiler shops for bridge building, steam boiler construction and shipbuilding. An important advantage is said to be that it is easily manipulated and transported.

RIVETED JOINTS

Net Section, Specification for. New Specification for Net Section of Riveted Tension Members, C. R. Young. Can. Engr., vol. 39, no. 16, Oct. 14, 1920, p. 427, 2 figs. Comparison of approximate values with theoretically correct dimensions.

ROAD CONSTRUCTION

Ideal Type. What is Considered the Ideal Type of Road, Contract Rec., vol. 34, no. 44, Nov. 3, 1920, pp. 1044–1046. Based on replies to questionnaire sent out to representative engineers.

Selection of Type. Selecting a Type of Road Surface. Public Works, vol. 49, no. 19, Nov. 6, 1920, pp. 430–432. Classification of surfaces suggested by Bur. of Public Roads.

ROAD MATERIALS

Testing. Report on Road Materials along the St. Lawrence River, From the Quebec Boundary Line to Cardinal, Ontario, R. H. Picher. Canada Dept. of Mines, bul. no. 32, 1920, 65 pp., 7 figs. Methods of testing.

ROADS

Wisconsin and Michigan. Trend of Highway Development—A Survey. Eng. News-Rec., vol. 85, no. 20, Nov. 11, 1920, pp. 920–922. Practice in Wisconsin and Michigan.

ROADS, ASPHALT

Illinois. Two Illinois Asphaltic Pavements, John B. Hitell. Public Works, vol. 49, no. 19, Nov. 6, 1920, pp. 432–434. Asphaltic concrete highway pavement on rich concrete base and sheet asphalt pavement of unusually stiff mix.

ROADS, BRICK

Design. Design and Construction of Brick Roads in Reno County, Kansas, M. W. Watson. Mun. & County Eng., vol. 59, no. 4, Oct. 1920, pp. 119–121, 6 figs. Base is $3^1/_2$ in. thick on sides and $5^1/_2$ in. thick at center. 3-in. vertical fiber brick is used as wearing course.

ROADS, CONCRETE

Mixing Plants. Development of Local Materials Aids Road Contractor. Eng. News-Rec., vol. 85, no. 18, Oct. 28, 1920, pp. 831–833, 5 figs. Ninebag batch mixer and other equipment used by Quilan & Robertson, Inc., New York City, in construction section of reinforced-concrete pavement in Pennsylvania.

Record Output for Central Concrete Mixing Plant. Public Works, vol. 49, no. 19, Nov. 6, 1920, pp. 434–436, 4 figs. How central mixing plant permitted laying 355 cu. yd. of seven-inch concrete pavement in a day, later increasing this to 425 with maximum haul of $3^3/_4$ miles.

ROADS, MACADAM

Tar Macadam. Tar Macadam Roads Show Lowest Total Annual Cost. Eng. News-Rec., vol. 85, no. 17, Oct. 21, 1920, pp. 783–784. Detailed cost figures on 14 highways covering six types.

ROLLING MILLS

Automobile Sheet. New Mill to Roll Automobile Sheets. Iron Age, vol. 106, no. 19, Nov. 4, 1920, pp. 1181–1185, 7 figs. Plant of Newton Steel Co., Newton Falls, Ohio. Sheets from 14 to 28 in. gage, in widths up to 48 in. and lengths up to 136 in. are manufactured.

Bureau of Rolling Mill Research. Design of Experimental Rolling Mill—V, W. B. Skinkle. Blast Furnace & Steel Plant, vol. 8, no. 11, Nov. 1920, pp. 614–616, 2 figs. Details of design of experimental mill of Bureau of Rolling Mill Research.

S

SCHOOLS

Industrial. Linking Education with Factory Profits, T. P. Hickey. Factory, vol. 25, no. 9, Nov. 1, 1920, pp. 1394–1396, 2 figs. Ford Motor Co. trade schools for boys.

SCIENTIFIC MANAGEMENT

See INDUSTRIAL MANAGEMENT.

SCREW MACHINES

Automatic. Galco Machines for the Automatic Manufacture of Screws (Machines Galco pour la fabrication automatique des vis). Revue générale de l'Electricité, vol. 8, no. 14, Oct. 2, 1920, pp. 455–457, 5 figs. Machines of Swedish manufacture.

SEARCHLIGHTS

Color of Light. Color and Spectral Composition of Certain High-Intensity Searchlight Arcs, Irwin G. Priest, W. F. Meggers, K. S. Gibson, E. P. T. Tyndall and H. J. McNicholas. Technologic Papers, Bur. of Standards, no. 168, Aug. 12, 1920, 14 pp., 8 figs. Investigations made with coöperation of Searchlight Investigation Section, Corps of Engineers, U. S. Army. It was calculated that color of light from these arcs is approximately equivalent to light of noon sun at Washington, although relatively more intense in blue-violet.

Remote Control. Searchlights with Remote Control (Ueber Scheinwerfer mit Fernantrieb), Alexander Zimmermann. Elektrotechnische Zeitschrift, vol. 41, no. 34, Aug. 26, 1920, pp. 667–670, 22 figs. Describes various arrangements for remote control with special reference to an arrangement patented by Carl Zeiss, for use mainly on board ship, which serves for the deflection of beams emitted from searchlights.

SEMI-DIESEL ENGINES

Anderson. The Anderson Semi-Diesel Oil Engine. Power, vol. 52, no. 18, Nov. 2, 1920, pp. 705–706, 3 figs. K-type engines manufactured by Anderson Foundry & Machine Co., Anderson, Ind.

Mercury Ignition. New Semi-Diesel Engine. Times Eng. Supp., vol. 16, no. 552, Oct. 1920, p. 325. Developed by Bessemer Gas Engine Co., Grove City, Pa., for use in oil fields. There is no water injection in engine. Ignition of fuel is secured by special mercury vaporizer.

SEWAGE DISPOSAL

Irrigation Plant. Experimental Sewage Irrigation Plant in Florida, F. E. Staebner. Eng. News-Rec., vol. 85, no. 18, Oct. 28, 1920, pp. 848–849, 3 figs. Filter effluent pumped to field. Discharge of risers on pipe laterals controlled by automatic float valves.

South Africa. Sewage Disposal in South Africa, Alfred E. Snape. Surveyor, vol. 58, no. 1502, Oct. 29, 1920, pp. 289–291. Comparison with practice in Great Britain.

SEWAGE PUMPING

Centrifugal Pump. Sewage Pumping Plants for Chicago Suburban Districts, Langdon Pearse. Eng. News-Rec., vol. 85, no. 19, Nov. 4, 1920, pp. 872–876, 6 figs. Electric centrifugal pumps with Diesel engine stand-by service. Large sluice gates and automatic rack cleaner.

SHAFT SINKING

Freezing Process. Modern Shaft-Sinking Methods (Die neueren Schachtabteufverfahren), H. Landgräben. Dinglers polytechnisches Jl., vol. 335, no. 17, Aug. 21, 1920, pp. 195–197. Notes on employment of freezing process in German mines and account of advantageous results obtained in comparison to electric pump method formerly used.

SHAFTS

Center-Crank Type. Experiences with Large Center-Crank Shafts, Louis Illmer. Mech. Eng., vol. 42, no. 11, Nov. 1920, pp. 610–612, 3 figs. Account of disastrous experience with large gas engine-shafts of center-crank type. Shafts were mounted upon three-point bearing supports and carried heavy flywheel between intermediate and outboard bearings. Stress diagrams indicate that this mode of support is likely to set up pernicious interaction of bearing load, culminating in excessive wear in intermediate main bearing.

Strength of. Strength of Shafts and Beams, John S. Watts. Am. Mach., vol. 53, no. 20, Nov. 11, 1920, pp. 909–910, 3 figs. Chart showing strengths of shafts considered as beams.

SHIP DESIGN

Center of Buoyancy. General Formulæ for the Vertical Position of the Center of Buoyancy, L. Pistner. Marine Eng., vol. 25, no. 11, Nov. 1920, pp. 908–909, 2 figs. Application of formulæ to extreme cases to be met with in practice.

SHIP PROPULSION

Diesel-Engine. Diesel Engines in Merchant Ships (Motori diesel sulle navi mercantil) Luigi Monetti. Revista Marittima, vol. 53, nos. 7 and 8, July-Aug. 1920, pp. 91–100, 5 figs. Advantages of Diesel-engine propulsion for ships.

Diesel-Engine-Electric. Diesel and Diesel-Electric Drive for Freighters, Carl Commentz. Motorship, vol. 5, no. 11, Nov. 1920, pp. 1007–1009, 1 fig. Questions of weight and propeller efficiency compared with steam drive from shipbuilder's point of view.

Diesel Engine vs. Steam Engine. The Present Position of the Marine Diesel Engine, James Richardson. Eng. & Indus. Management, vol. 4, no. 18, Oct. 28, 1920, pp. 554–557. Comparison of running costs of Diesel-engined ships and steamships.

Electric. See SHIP PROPULSION, ELECTRIC.

Self-Propulsion Experiments. Self-Propulsion Experiments. Shipbuilding and Shipping Rec., vol. 16, no. 15, Oct. 7, 1920, pp. 429–430, 2 figs. Deducted curves of e.hp. for single- and quadruple-screw vessels.

SHIP PROPULSION, ELECTRIC

Cargo Vessels. Electric Drive Applied to Cargo Vessels. Power, vol. 52, no. 18, Nov. 2, 1920, pp. 706–708, 5 figs. Details of electric drive in the Eclipse, the first merchant vessel thus fitted in United States.

First Electric-Driven Freighter. Mar. Rev., vol. 50, no. 11, Nov. 1920, pp. 582–584, 7 figs. System of propulsion in steamer Eclipse, which is first electrically driven general cargo merchant vessel in United States. Vessel was placed in service in Jersey City, N. J., in 1920.

Electric Propelling Unit of the Eclipse. Marine Eng., vol. 25, no. 11, Nov. 1920, pp. 890–895, 9 figs. First general cargo merchant vessel in United States to be equipped with electric drive. Dimensions: Length overall, 440 ft.; beam, 56 ft.; deadweight capacity, 11,868 tons; hp., 3000.

SHIPBUILDING

Economies. Shipbuilding Economies, G. A. Bisset. Marine Eng., vol. 25, no. 11, Nov. 1920, pp. 871–879 and p. 907, 22 figs. Methods employed at Puget Sound Navy Yard for reducing cost of ship construction.

United Kingdom. Lloyd's Register Shipbuilding Returns. Shipbuilding & Shipping Rec., vol. 16, no. 17, Oct. 21, 1920, pp. 485–486. Figures for quarter ended Sept. 30, 1920.

SHIPS

Cargo. 6,300-Ton Deadweight Freighter. Marine Eng., vol. 25, no. 11, Nov. 1920, pp. 885–890, 6 figs. Economical type of cargo steamer designed by Baltimore Dry Docks and Ship Building Company. Dimensions: Length overall, 356 ft.; beam, molded, 49 ft.; depth molded, 28 ft. $7^1/_2$ in.; total deadweight, 7300 tons; i.hp., 2000.

Fabricated. The Future of the Fabricated Ship. Eng., vol. 110, no. 2858, Oct. 8, 1920, pp. 464–469, 12 figs. Data relating to fabricated ships constructed in U. S.

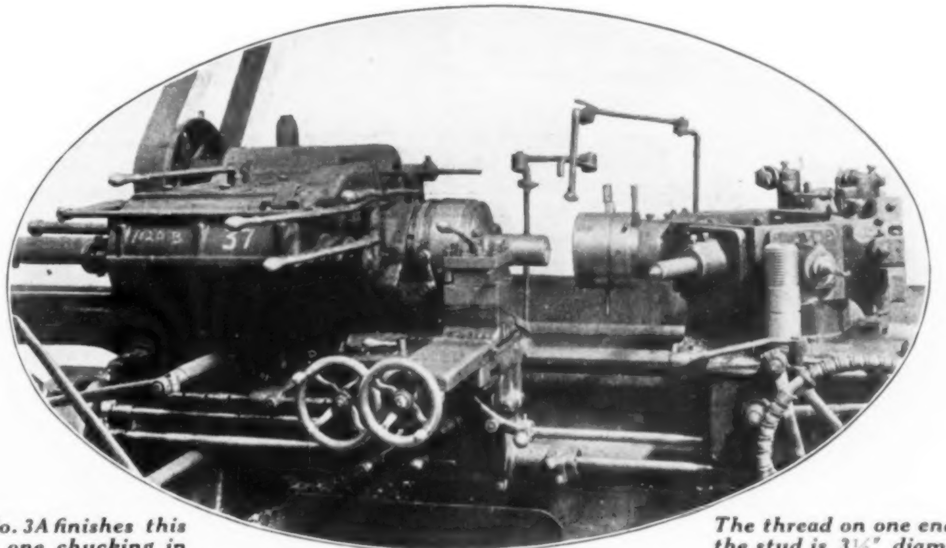
Heeling. Heeling Ships, I. C. Hanscom. Marine Eng., vol. 25, no. 11, Nov. 1920, pp. 904–907, 6 figs. Heeling apparatus.

Imperator Type. Technical and Economic Discussion of the Development, Construction and Operation of German Express Steamers of the Imperator Type (Technische und wirtschaftliche Betrachtungen über die Entstehung, den Bau und die Inbetriebnahme der deutschen Schnelldampfer vom Typ "Imperator"), Julius Eggers. Schiffbau, vol. 21, no. 44–45, Sept. 22–29, 1920, pp. 1187–1195. Notes on origin and unavoidable difficulties encountered in putting these giant ships into service, hitherto not made public for business, political and economic reasons. Writer concludes, in reply to numerous recent assertions of the foreign press that the Imperator and Vaterland have not given satisfaction and cannot be brought to high speed, that this is probably due to lack of efficiency of the crew as compared to former German crew.

Passenger. Passenger Accommodations on Shipping Board Steamship Panhandle State. Marine Eng., vol. 25, no. 11, Nov. 1920, pp. 880–884, 7 figs. Arrangement of living quarters on first passenger vessel completed by American yard for United States Shipping Board. Dimensions: Length overall, 522 ft. 5 in.; beam, molded, 62 ft.; depth to "A" deck, 42 ft.; i.hp. 7000; deadweight tonnage, 13,100.

Twin-Screw Channel Steamer "Bruges" for the G. E. Railway Service. Eng., vol. 110, no. 2857, Oct. 1, 1920, p. 452, 1 fig. Dimensions: Length on water line, 330 ft.; breadth, 43 ft.; depth to shelter deck, 26 ft. 6 in.

Welded. Welded Ship Plating with Pressed-In Stiffening Ribs (Geschweisste Eisenbeplattung mit eingepressten Versteifungen (D.R.P.)). Autogene Metallbearbeitung, vol. 13, no. 12, June 15, 1920, pp. 131–133, 4 figs. Description of a welded plating which, in comparison with riveted platings,



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ENGINEERING INDEX (Continued)

is said to effect 27 per cent saving in material and about 40 per cent saving in labor, and to overcome all the defects originating in the welding together of large plate connections.

SHIPS, CONCRETE

Construction. Notes on Concrete Ship Construction, I. B. McDaniel. Tech. Eng. News, vol. 1, no. 7, Nov. 1920, pp. 2–3, 4 figs. Method used at San Francisco Shipbuilding Co. in construction of two 7500-ton tankers for U. S. Shipping Board.

SHOVELS

Rotary. Clère Rotary Shovel (La pelle mécanique rotative Clère), E. Weiss. Nature (Paris), no. 2423, Sept. 11, 1920, pp. 174–176, 5 figs. Shovel resembling paddle wheel operated by steam and provided with accessories for loading loose materials on railway cars and other similar uses.

SILVER METALLURGY

Recovery from Manganese-Silver Ores. Recovery of Silver from Manganese-Silver Ores, Jay A. Carpenter. Eng. & Min. Jl., vol. 110, no. 19, Nov. 6, 1920, pp. 898–902. Chloridizing roasting followed by cyaniding offers considerable promise on material which cannot be treated by less costly processes. Volatilization and recovery by Cottrell process also being developed.

SNOW REMOVAL

Tests. Snow Removal Tests. Public Works, vol. 49, no. 19, Nov. 6, 1920, pp. 427–429, 2 figs. Experimental tests of New York City Street Cleaning Department.

SPARK PLUGS

Sparking Potential. The Sparking Potential of Spark Plugs. Automotive Industries, vol. 43, no. 18, Oct. 28, 1920, pp. 864–865, 1 fig. Tests made by engine sub-committee of British National Advisory Committee for Aeronautics.

The Sparking Voltages Between Spherical Electrodes, Alexander Russell. Jl. Instn. Elec. Engrs., (Supp.), vol. 57, part 2, Oct. 1920, pp. 223–230. Formulæ for maximum electric stress between equal spherical electrodes.

SPRINGS

Spiral. Spiral Springs, P. H. Parr. Mech. World, vol. 68, no. 1762, Oct. 8, 1920, pp. 256–257. Formulæ and tables for designing them.

STANDARDIZATION

Revolutions per Minute. The Standardization of the Number of Revolutions (Ueber die Normalisierung von Drehzahlen), Reinhold Rüdenberg. Betrieb, vol. 2, no. 14, Aug. 1920, pp. 352–357, 4 figs. Recommends establishment of a certain series of standard revolution numbers to which the future construction of machines should be limited.

STANDARDS

German N. D. I. Report. Report of the German Industry Committee on Standards (Mitteilungen des Normenausschusses der Deutschen Industrie). Betrieb, vol. 2, no. 15, Aug. 1920, pp. 373–389, 24 figs. Proposals of the Board of Directors for allowances of standard holes and shafts; machining accuracy of limit gages; cylindrical and conical boring bushes; and disk keys. Proposed standards for determination of hardness according to Brinell's method; set screws and counterborings of splines; and machine-tool handles.

The Standardization of Bores, Wheel Widths and Rounding of Teeth on Change Gears (Normung der Bohrungen, Radbreiten und seitlichen Rundungen an Wechselrädern), H. Toussaint. Betrieb, vol. 2, no. 16, Sept. 1920, pp. 410–411, 2 figs. Report of the working committee for pinions.

Report of the German Industry Committee on Standards (Mitteilungen des Normenausschusses der Deutschen Industrie), Betrieb, vol. 2, no. 16, Sept. 1920, pp. 401–409, 12 figs. Proposals of Board of Directors for snap gages, and soft steel pipes for gases and liquids. Proposed new standards for binding screws and for wrench openings.

Hollow Brick. Hollow Brick Standards (Normen für Hohlziegel), L. Schmelzer. Zielgelwelt, vol. 51, no. 29, July 24, 1920, pp. 325–327, 1 fig. Writer refers to his own and K. Dümmler's recommendations for standards.

STANDPIPES

Concrete. Concrete Standpipe for 110 ft. Head at Kansas City, T. D. Samuel, Jr. Eng. News-Rec., vol. 85, no. 18, Oct. 28, 1920, pp. 841–843, 5 figs. With 40 ft. diameter has capacity of 1,000,000 gallons. Top is 134 ft. above ground. Has joint at base.

STEAM ENGINES

Uniflow. The Uniflow Steam-Engine, F. B. Perry. Jl. Inst. Mech. Engrs., no. 6, Oct. 1920, pp. 731–743 and (discussion) pp. 743–764, 20 figs. History, principle of work and details of construction.

STEAM PIPES

High-Pressure. High-Pressure Steam Lines (Beitrag zum Kapitel Hochdruckdampfleitungen), Eduard Kaschny. Der praktische Maschinen-Konstrukteur, vol. 53, no. 35–36, Sept. 2, 1920, pp. 305–313, 9 figs. Discusses movement of gases in pipe lines according to results of various experiments and describes fittings for modern plants. Schematic diagrams illustrating how plant should be constructed with regard to economy and safety of operation. Calculation of diameter of pipe lines, pressure and heat losses, and insulation are carried out with aid of graphic charts.

STEEL

Arc-Fused. Metallography of Arc-Fused Steel, Henry S. Rawdon, Edward C. Groesbeck and Louis Jordan. Chem. & Metallurgical Eng., vol. 23, no. 16, Oct. 20, 1920, pp. 777–782, 38 figs. Various lines of investigations are utilized to support idea that microscopic "plates" existing in fusion welds are due to nitrogen; that plates are very persistent, and are not responsible for low ductility of metallic piece.

Bars, Specifications. Specifications for Steel Bars for Other Uses than the Manufacture of Machine Tools (Cahier des charges pour la fourniture de barres en aciers au carbone autres que les aciers à outils), Revue de Métallurgie, vol. 17, no. 8, Aug. 1920, pp. 555–560. Adopted by Commission permanente de Standardisation.

Copper, Developments in. A Review of the Development of Copper Steel, D. M. Buck. Iron Age, vol. 106, no. 18, Oct. 28, 1920, pp. 1109–1110. Bibliography of subject. Use of product in steel freight cars. (Abstract.) Paper read before Am. Iron & Steel Inst.

Review of the Development of Copper Steel, D. M. Buck. Blast Furnace & Steel Plant, vol. 8, no. 11, Nov. 1920, p. 593. Discusses results of various researches since 1900 and advises adoption of copper-bearing steel in other sections than sheets. Bibliography of recent literature.

Elastic Strength. Relative Elastic Strengths of Steel. Can. Engr., vol. 39, no. 18, Oct. 28, 1920, pp. 465–468, 1 fig. Relation of elastic strengths in shear, tension and compression. Guest's law is claimed to be erroneous, and it is held that establishment of correct ratios improves design of structural elements subject to combined stresses.

Electric. Electric Steels, C. G. Carlisle. Eng., vol. 110, no. 2857, Oct. 1, 1920, pp. 456–457. Diagram showing relation of cutting speed to durability. (Abstract.) Paper read before Iron & Steel Inst.

Impurities, Detection of. An Electrometric Method for Detecting Segregation of Dissolved Impurities in Steel, E. G. Mahin and R. E. Brewer. Jl. Indus. & Eng. Chem., vol. 12, no. 11, Nov. 1920, pp. 1095–1098, 3 figs. Method developed at chemistry laboratory of Purdue University, Lafayette, Ind., for measuring electrode potential of single grain or microscopic point on metal specimen. Application of method to piece of steel containing segregated ring of ferrite, produced by heating in contact with aluminum bronze, developed that average values for ferrite ring were 0.051 volt lower than for ferrite in unaffected body of steel. This was considered indication of different degree of purity for ferrite under two conditions, and theory is advanced to account for ferrite ring.

Inclusions. Inclusions and Ferrite Crystallization in Steel. II—Solubility of Inclusions, E. G. Mahin and E. H. Hartwig. Jl. Indus. & Eng. Chem., vol. 12, no. 11, Nov. 1920, pp. 1090–1095, 3 figs. Alloys and special steels were turned into small rods and driven into holes in carbon steels, and the whole was then heated to temperatures above transformation range for steel. Section of slowly cooled piece showed in nearly all cases, ferrite segregation around insert. Hypothesis to explain phenomenon is advanced and character of influence of nonmetallic inclusions upon ferrite segregation is discussed.

Notched-Bar Tests. Experimental Study on Impact Tests of Notched Bars (Etude expérimentale sur les essais au choc des barreaux entaillés), André Cornu-Thénard. Revue de Métallurgie, vol. 17, no. 8, Aug. 1920, pp. 536–554, 5 figs. Comparative study of machines and processes. (To be continued.)

Open-Hearth, Basic. High Manganese Iron in Basic Open-Hearth Practice, E. A. Wheaton. Iron Age, vol. 106, no. 18, Oct. 28, 1920, pp. 1112–1114. Paper read before Am. Iron & Steel Inst.

Manganese Iron as Desulphurizer, E. A. Wheaton. Iron Trade Rev., vol. 67, no. 18, Oct. 28, 1920, pp. 1196–1198. Tests indicate that use of high manganese pig iron enables open-hearth operators to maintain low sulphur content in basic steel. Practice does not reduce tonnage. (Abstract.) Paper read before Am. Iron & Steel Inst.

Making Basic Open-Hearth Steel, F. L. Toy. Iron Trade Rev., vol. 67, nos. 18 and 19, Oct. 28, and Nov. 4, 1920, pp. 1199–1201 and 1275–1277 and (discussion) pp. 1277–1278. Oct. 28: Developments in device and methods for preserving and lengthening life of furnace. Merits of various fuels for melting charges. Efficiency of furnaces; Nov. 4: Working high-sulphur pig iron by use of heavy lime burdens results in an excessive slag volume. Importance of manganese in controlling fluidity and basicity of slag. Pouring temperature discussed. Paper read before Am. Iron & Steel Inst. (Abstract.)

The Basic Open-Hearth Process, F. L. Toy. Iron Age, vol. 106, nos. 18 and 19, Oct. 28 and Nov. 4, 1920, pp. 1116–1119 and 1193–1195. Paper read before Am. Iron & Steel Inst.

Use of High Manganese Iron in Basic Open Hearth Practice, E. A. Wheaton. Blast Furnace & Steel Plant, vol. 8, no. 11, Nov. 1920, pp. 596–598. Paper read before Am. Iron & Steel Inst.

Production in Electric Furnace. Producing Acid Steel Electrically, James W. Galvin and Charles N. Ring. Iron Trade Rev., vol. 67, no. 17, Oct. 21, 1920, pp. 1130–1132. It is held furnace bottoms should be cup instead of saucer shaped. Effect of melting efficiency of degrees of compactness of scrap charged into furnace is studied.

[See also ALLOY STEELS; STEEL, HIGH-SPEED; NICKEL STEEL.]

STEEL CASTINGS

Heat Treatment. Heat Treatment Improves Castings, Fred Grotts. Foundry, vol. 48, no. 21, Nov. 1, 1920, pp. 859–860 and 881, 14 figs. Strength and elongation of cast-steel tractor parts are improved by quench-and-draw treatment. Danger from hardening cracks eliminated by removing castings from water before entirely cool. Paper read before Am. Foundrymen's Assn.

STEEL, HEAT TREATMENT OF

Automobile Steels. The Heat Treatment of Automobile Steels, R. R. Abbott. Iron Age, vol. 106, no. 18, Oct. 28, 1920, pp. 1110–1112, 2 figs. Also Iron Trade Rev., vol. 67, no. 18, Oct. 28, 1920, pp. 1202–1203, 2 figs. Calculation of critical temperatures. Classification of automobile steels. Paper read before Am. Iron & Steel Inst.

Crystalline Structure Produced. Critical Heat Treatment After Critical Cold Working of Low-Carbon Steel (Kritische Wärmebehandlung nach kritischer Kaltformgebung von kohlenstoffarmen Flusseisen), A. Pomp. Stahl u. Eisen, vol. 40, nos. 38, 41 and 42, Sept. 23, Oct. 14 and 21, 1920, pp. 1261–1269, 1366–1378 and 1403–1415, 47 figs. 13 on supp. plate. Based on review of literature, a summary of conditions is given under which coarsely crystalline structure is produced in cold-worked and annealed material. Gives numerical data concerning the changes in the tensile-strength properties due to critical heat treatment after critical cold working, based on experiments described.

Dendritic Formation. Dendritic Steel, H. G. Carter. Trans. Am. Soc. for Steel Treating, vol. 1, no. 1, Oct. 1920, pp. 56–61, 10 figs. It is concluded from results obtained in experiments and microscopic examinations of bars that dendritic steel cannot be broken up structurally, and, therefore, stripping a casting while very hot gives rise to dendritic steel, while if casting is allowed to cool slowly dendrites will be broken up. Hot stripping is condemned as very bad practice.

Electric-Furnace. Heat Treating Steel Electrically, E. F. Collins. Foundry, vol. 48, no. 357, Oct. 15, 1920, pp. 826–830, 12 figs. Test data showing heat uniformity of electric furnace. Paper read before Am. Foundrymen's Assn.

Gas-Fired Furnaces. Hardening Steel in Gas-Fired Furnaces, W. A. Ehlers. Sci. Am., vol. 124, no. 18, Oct. 30, 1920, pp. 450 and 460, 3 figs. Details of furnaces.

Gas vs. Fuel Oil. Producer Gas for Heat Treating, Geo. H. Trout. Trans. Am. Soc. for Steel Treating, vol. 1, no. 1, Oct. 1920, pp. 51–55. Results of comparative tests using fuel oil and gas.

Hardening. Recent Processes for the Hardening of Steel and Iron (Neuere Verfahren zur Härtung von Stahl und Eisen), W. Hacker. Metall-Technik, vol. 36, no. 33–34, Aug. 23, 1920, pp. 129–131. Review of important patents and processes during last few years.

STEEL, HIGH-SPEED

Chromium Determination. The Influence of Vanadium on the Determination of Chromium in High-Speed Tool Steel Containing Tungsten (Einfluss des Vanadins auf die Chrombestimmung in wolframhaltigen Schnelldrehstählen), P. Slawik. Chemiker-Zeitung, vol. 44, no. 103, Aug. 26, 1920, p. 633. Results of experiments are said to show that if certain given directions are carried out, determination of chromium need not be affected by the reddish brown coloring frequently observed in the titration of chromium with iron sulphate.

STEEL INDUSTRY

Europe. European Iron and Steel in 1920, H. Cole Estep. Iron Trade Rev., vol. 67, no. 18, Oct. 28, 1920, pp. 1204–1210, 8 figs. Two years after war England and continental countries with exception of Germany and Russia are regaining prewar capacity. (Abstract.) Paper read before Am. Iron & Steel Inst.

India. India's Steel Industry Expanding, Charles P. Perin. Iron Trade Rev., vol. 67, no. 19, Nov. 4, 1920, pp. 1273–1274. Extension and improvements to blast furnaces and mills will guarantee output of pig iron and steel greater than domestic needs. Country may soon place products in markets of world. (Abstract.) Paper read before Am. Iron & Steel Inst.

The Iron and Steel Industry in India, Charles Page Perin. Iron Age, vol. 106, no. 18, Oct. 28, 1920, pp. 1119–1122, 1 fig. Paper read before Iron & Steel Inst.

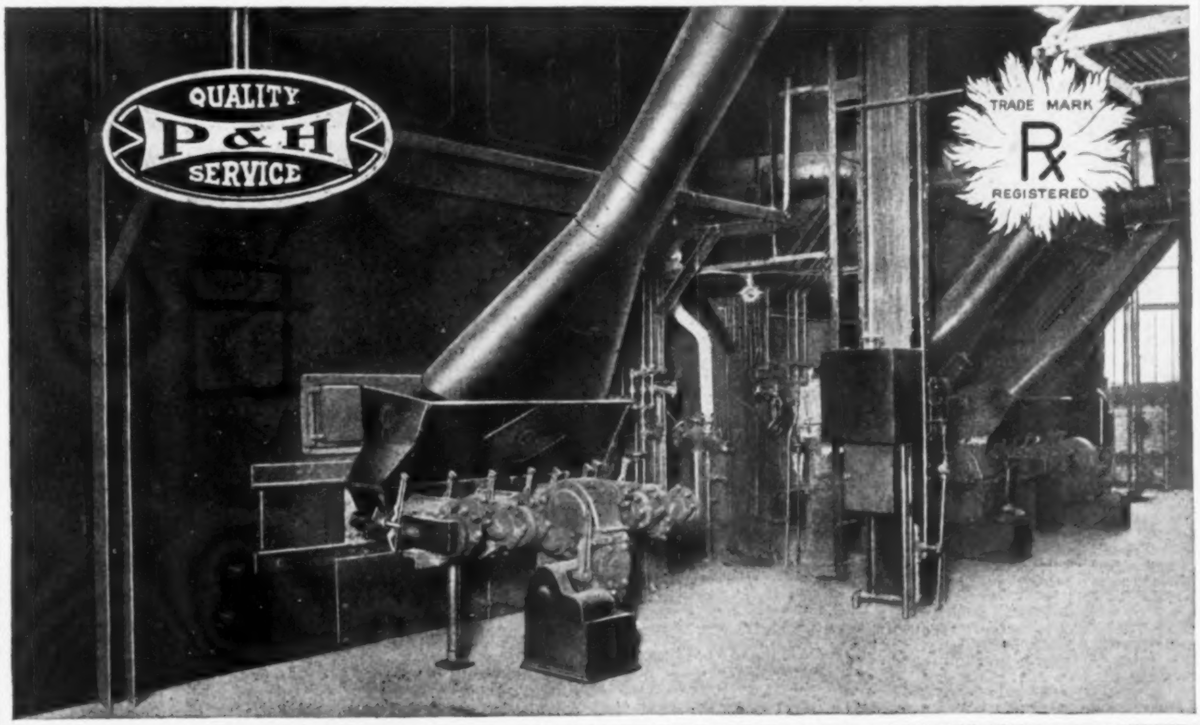
South Africa. South African Iron and Steel. Eng., vol. 110, no. 2858, Oct. 8, 1920, pp. 478–480. Possibilities of establishing large iron and steel industry.

Status of. Must Help to Stabilize Business, Elbert H. Gary. Iron Trade Rev., vol. 67, no. 18, Oct. 28, 1920, pp. 1192–1193. Optimistic outlook is made of future developments in steel industry. Tendency, writer says, is towards lower, more reasonable and fairer relative basis. (Abstract.) Presidential address before Am. Iron & Steel Inst.

STEEL MANUFACTURE

Basset Process. Will Exploit New Steelmaking Process, Francis Miltoun. Iron Trade Rev., vol. 67, no. 20, Nov. 11, 1920, p. 1335. Process for making iron and steel direct from ore using an inclined rotating furnace similar to that employed in manufacture of cement. Process was invented by Lucien Basset and is about to be exploited by French company.

Deoxidizers. New Deoxidizers for Steel Manufacture, J. R. Cain. Chem. & Metallurgical Eng., vol. 23, no. 18, Nov. 3, 1920, pp. 879–882. Report



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ENGINEERING INDEX (Continued)

of coöperative investigation sponsored by National Research Council on function and action of deoxidizers, together with experimental work to find low-melting mixtures of scavenging oxides.

[See also ELECTRIC FURNACES, Operating Data; Steel Refining; United Kingdom; IRON METALLURGY, Direct Process.]

STEEL WORKS

Africa. Steel Plants of Africa. Iron Age, vol. 106, no. 20, Nov. 11, 1920, p. 1270. Report on present condition of industry and estimate of requirements.

British. Baldwins, Ltd., Adds New Plant, Joseph Horton. Iron Trade Rev., vol. 67, no. 17, Oct. 21, 1920, pp. 1133–1138, 20 figs. Self contained unit being completed in South Wales district by British steel syndicate. Parent company, capitalized at $35,000,000 controls works in England, Wales and Canada.

Schneider Works, France. The Iron, Steel, and Engineering Works of Messrs. Schneider and Co. Engr. (Supp.), vol. 130, no. 3377, Sept. 17, 1920, 16 pp., 22 figs. Description of chief works of company in France, particularly works at Creusot and Breuil.

The New Steel Works at Breuil (La nouvelle aciérie du Breuil). Génie Civil, vol. 77, no. 15, Oct. 8, 1920, pp. 285–291, 10 figs. partly on supp. plate. Subsidiary to Creusot works. There are eight furnaces, one acid and 7 basic, five of 50- to 60-ton and two of 25- to 30-ton capacities.

Sheet Mills. Material Handling Equipment is Important Factor in New Sheet Mill, E. L. Shaner. Iron Trade Rev., vol. 67, no. 19, Nov. 4, 1920, pp. 1266–1270, 9 figs. Automatic charging machines for sheet and annealing furnaces, crane equipment and electric tractor and trailer system, at works of Newton Steel Co.

STOKERS

Coking. The "Bennis" Patent Coking Stoker. Practical Engr., vol. 62, no. 1755, Oct. 14, 1920, pp. 250–253, 2 figs. Fuel is fed in bulk at front of moving grate, coking taking place and volatile portions being distilled off, while burning mass is gradually conveyed by mechanical means towards rear of grate.

Forced-Draft. Stowe Forced-Draft Stoker. Power, vol. 52, no. 16, Oct. 19, 1920, pp. 624–626, 5 figs. Type developed by Laclede-Christy Clay Products Co., St. Louis, Mo. It consists of traveling chain-grate elements alternating with stationary tuyères.

STREET RAILWAYS

Cars, Safety. One-Man Safety Car Meeting Approval on Many Canadian Systems. Elec. News, vol. 29, no. 21, Nov. 1, 1920, pp. 41–46, 5 figs. Thirteen towns and cities are operating them wholly or in part. It is said that platform expenses have reduced, accidents are almost unknown, schedule is maintained, and service is satisfactory.

Kansas City, Mo. Rerouting Plan to Save $620,000. Elec. Ry. Jl., vol. 56, no. 19, Nov. 6, 1920, pp. 957–961, 6 figs. Report of consulting engineer on Kansas City railways.

Pavement and Construction. Why Street Railways Should Bear Share of Pavement Cost. Eng. News-Rec., vol. 85, no. 17, Oct. 21, 1920, pp. 795–796. Brief of data from 166 cities gives reasons why two-foot strip outside rails should not be diminished.

Regenerative vs. Pneumatic Braking. Street Railway Braking (Beitrag zur Frage der Strassenbahnbremsen), W. Pforr. Elektrische Kraftbetriebe u. Bahnen, vol. 18, no. 12, Apr. 24, 1920, pp. 105–108. Refers to articles appearing in preceding volume of same journal on the relative merits of the purely electric brake and the pneumatic brake with regard to efficiency, safety and economy; and presents table giving operating data of the Buenos Aires (Argentine) street railway during the years 1911–1918, collected and compiled by author, demonstrating the satisfactory use of the short-circuit brake.

Track Deformations. The Deformation of Street Railway Tracks Under Rolling Loads (Die Formänderungen des Strassenbahngleises unter der rollenden Last), H. Bloss. Elektrische Kraftbetriebe u. Bahnen, vol. 18, nos. 10 and 11, Apr. 4 and 14, 1920, pp. 81–85 and 93–97, 21 figs. Account of measurements carried out by author in 1913, with description of measuring method and apparatus employed. Notes on deflection of rail and coefficient of ballast; and the internal deformations of track.

Zone Fares. How the Zone Fare Has Made Good at San Diego. Elec. Ry. Jl., vol. 56, no. 20, Nov. 13, 1920, pp. 1009–1012, 5 figs. In spite of low density of population, high mileage of track, large number of private automobiles and decrease in military and naval population, company shows 40 per cent more revenue and 12 per cent more passengers for first nine months of 1920 as against same period of 1919.

SUBMARINE WARFARE

Detection of Submarines. Modern Marine Problems in War and Peace, C. V. Drysdale. Eng., vol. 110, nos. 2858, 2859 and 2860, Oct. 8, 15 and 22, 1920, pp. 484–486, 6 figs., 521–523, 9 figs., and 552–554, 4 figs. Eleventh Kelvin lecture delivered before Instn. Elec. Engrs.

SUBMARINES

Periscopes. The Construction of U-Boats at the Germania Shipyards (Der Bau von Unterseebooten auf der Germaniawerft), H. Techel. Zeit. des Vereines deutcher Ingenieure, vol. 64, no. 43, Oct. 23, 1920, pp. 882–888, 36 figs. Notes on periscopes, with details of various types, including the multiocular. the panorama and zenith periscope. Describes latest development by the C. P. Goerz Corp., the upright periscope, which differs from previous models in that it consists of two tubes, the ocular and objective, and can be rolled in and out without the observer having to change his position according to the height. (Continuation of serial.)

SUBWAYS

Berlin. The Construction of the Berlin Elevated and Subway Line Through Built-Up Sections of the City (Führung der Berliner Hoch- und Untergrundbahnen durch bebaute Viertel). Verkehrstechnik, vol. 37, no. 25, Sept. 5, 1920, pp. 345–350, 15 figs. Describes, among other things, the building of tunnels under existing buildings without interrupting or interfering with their use for office or living purposes. Details of new section under construction in which line is constructed partly as elevated, through a row of buildings and courts, not as open track, but entirely enclosed with walls and roof in order to protect neighboring houses from noise and sight of railway. Abstract of book by P. Wittig, Director of Elevated & Subway Co., Berlin.

New York City. Rapid Transit Plan for New York Proposes 830 miles of New Track. Eng. News-Rec., vol. 85, no. 16, Oct. 14, 1920, pp. 754–757, 1 fig. Report of chief engineer of Transit Construction Committee. Twenty-one subaqeous tunnels and three moving platforms are recommended.

Stations. A Study of Rapid Transit Station Design, Olof A. Nilsson. Eng. News-Rec., vol. 85, nos. 18 and 19, Oct. 28 and Nov. 4, 1920, pp. 824–829, 12 figs., and 894–899, 11 figs. Possibilities for great time saving in platform arrangement. Nov. 4: Good and bad features in arrangement of platforms and street approaches. Dimensions and capacities that have been found satisfactory.

SULPHURIC ACID

Addition Compounds. The Formation of Addition Compounds Between 100% Sulfuric Acid and the Neutral Sulfates of the Alkali Metals, James Kendall and Mary Louise Landon. Jl. Am. Chem. Soc., vol. 42, no. 11, Nov. 1920, pp. 2131–2142, 2 figs. Experimental investigations of means of freezing-point method upon compound formation in systems containing sulphuric acid and anhydrous neutral sulphates of potassium, ammonium, sodium and lithium from eutectic point of each system up to temperature of 300 deg. cent.

Concentration. The Concentration of Sulphuric Acid, S. J. Tungay. Chem. Age (Lond.), vol. 3, no. 70, Oct. 16, 1920, pp. 416–417, 2 figs. Describes more important systems of concentration, and discusses their relative merits as regards durability, economy of working, fuel consumption, and general efficiency.

T

TAPS

Square and Acme Thread. The Design of Square and Acme Thread Taps of Steep Lead, E. A. Dixie. Am. Mach., vol. 53, no. 20, Nov. 11, 1920, pp. 887–888, 7 figs. Methods of manufacture.

TAR

Removal from Coke Gas. Removing Tar from Coke Gas—V, A. Thau. Iron Trade Rev., vol. 67, no. 20, Nov. 11, 1920, pp. 1331–1335, 10 figs. Rotary tar extractors.

TELEGRAPHY

Research. Report on the Activity of the Telegraph Testing Bureau in the Years 1913–1918 (Bericht über die Tätigkeit des Telegraphen-Versuchsamts in den Jahren 1913–1918). Telegraphen- u. Fernsprech-Technik, vol. 9, no. 5–6, Aug. 1920, pp. 69–85, 11 figs. Report of experimental results of investigations of the dielectric properties of different insulating materials, etc.; the closure of currents; lines and wirings; the technique of telegraphy and telephony; wireless telegraphy; disturbances due to strong current; apparatus; problems of illumination; etc.

TELEPHONY

Automatic. Automatic Telephone Progress. Elecn., vol. 85, no. 2214, Oct. 22, 1920, pp. 466–471, 8 figs. Introduction of panel automatic system into City of London.

High-Frequency. High-Frequency Telephony in Long-Distance Stations (Hochfrequenztelephonie in Ueberlandzentralen), H. Gewecke. Elektrotechnische Zeitschrift, vol. 41, no. 34, Aug. 26, 1920, pp. 670–672, 4 figs. Experiments show that even in the case of serious disturbances in the wiring system, the radio communication can be maintained. Description of first radiotelephonic connection constructed by the Radiotelegraphy Co., Ltd., along the 135-km. high-frequency line Golpa-Rummelsburg, and discussion of relative costs of telephone systems with and without wire.

London System. The Telephone Service of Large Cities, with Special Reference to London, E. A. Laidlaw and W. H. Grinsted. Jl. Instn. Elec. Engrs. (Supp.), vol. 57, part 2, Oct. 1920, pp. 158–188 and (discussion) pp. 188–201, 14 figs. Proposal is made for introduction of "unit of telephone service" as basis of charge made to subscriber. Duration of conversation determines charge.

TELESTEREOGRAPHY

Belin System. Sending Photographs Over Wires, Austin C. Lescarboura. Sci. Am., vol. 123, no. 19, Nov. 6, 1920, pp. 474–483–484, 3 figs. Belin system for sending actual photographs over ordinary telegraph wire. Photograph is received on sensitized cylinder. Quivering ray of light, originated by electric current from transmitter, operates at receiving end successively upon all parts of a sensitized paper cylinder, intensity of light varying so as to reproduce photograph.

TERMINALS, MARINE

Portland, Ore. Port Terminal Pier Design at Portland, Ore., G. B. Hegardt. Eng. News-Rec., vol. 85, no. 17, Oct. 21, 1920, pp. 796–797, 1 fig. Considerations which led to adoption of wide piers and handling machinery in new municipal docks.

TERMINALS, RAILWAY

Design. The Grouping of the Rail Lines in Terminal Stations with Through Passage for Trains (Ueber die Gruppierung der Geleise bei Kopfbahnhöfen), Rob. Findeis. Schweizerische Bauzeitung, vol. 76, nos. 14 and 15, Oct. 2 and 9, 1920, pp. 153–155 and 165–167, 10 figs. Theoretical study of possible line arrangements, inspired by the expert testimony of Cauer, Moser and Gleim, relative to the proposed extension of the Zurich main railroad station.

TESTING MACHINES

Transverse Tests on Cast Iron. Develops New Machine for Bending Tests. Iron Trade Rev., vol. 67, no. 17, Oct. 21, 1920, pp. 1139–1140, 1 fig. Hand-operated transverse and bend testing machine actuated by oil pressure. Developed by Alfred J. Amsler & Co., Switzerland.

THERMOCOUPLES

Junctions. The Construction of Thermocouples by Electro-Deposition, Wm. Hamilton Wilson and Miss T. D. Epps. Physical Soc. of London, Proc., vol. 32, part 5, Aug. 15, 1920, pp. 326–340, 15 figs. Method devised to overcome difficulty of making satisfactory soldered joints between elements of thermopiles having large number of closely packed junctions, consists in using continuous wire of one of elements and coating those parts of it which have to form other element with electrolytic deposit of another metal.

THERMOMETERS

Mercury, Standardization of. Standardization of Mercury Thermometers (Normalissierung von Quecksilberthermometern), H. Siebert and Karl Scheel. Zeit. für angewandte Chemie, vol. 33, no. 73, Sept. 10, 1920, p. 216. Recommendations for standardization of ordinary thermometers and the Allihn and Anschütz composition thermometers.

TIDAL POWER

Utilization. Utilization of the Tides (Utilisation des marées) Amiral Amet. Revue générale de l'Électricité, vol. 8, nos. 14 and 15, Oct. 2 and 9, 1920, pp. 445–455, and 483–492, 15 figs. General theory. Coördination of available data. (To be continued.)

TOOLS

Steel, High-Speed. High-Speed Cast Steel Tools from the Electric Furnace, Sterling H. Bunnell. Iron Age, vol. 106, no. 20, Nov. 11, 1920, pp. 1258–1259, 3 figs. Practice of United States High-Speed Steel & Tool Corporation in making tools ready for use in any desired shape.

TOWN PLANNING

France. Reconstruction Progress and City Planning in France, George B. Ford. Eng. & Contracting, vol. 54, no. 17, Oct. 27, 1920, pp. 421–422. Compulsory city planning law in France. Paper read before Am. Soc. for Mun. Improvements.

TRACTORS

Castings. Heat Treating Tractor Castings, Fred Grotts. Iron Trade Rev., vol. 67, no. 20, Nov. 11, 1920, pp. 1346–1348, 12 figs. Research work conducted by Holt Mfg. Co., Peoria, Ill. (Abstract.) Paper read before Am. Foundrymen's Assn.

Manufacture. Operations in Building Tractors, Fred H. Colvin. Am. Mach., vol. 53, no. 20, Nov. 11, 1920, pp. 877–883, 25 figs. Methods at works of C. L. Best Gas Traction Co., California.

Tests. Tractors at the Royal Agricultural Society's Trials at Lincoln. Eng., vol. 110, no. 2858, Oct. 8, 1920, pp. 472–474, 476 and 481–482, 10 figs. Particulars of competing tractors and account of trials.

Tractors Perform Effectively in British Trials, M. W. Bourdon. Automotive Industries, vol. 43, no. 18, Oct. 28, 1920, pp. 856–860, 16 figs. Account of 1920 British tractor trials. There were 46 entries all except two of which were powered by internal-combustion engines.

TRAIN CONTROL

Automatic. Test of Shadle Automatic Train Control. Ry. Signal Engr., vol. 13, no. 10, Oct. 1920, pp. 404–405, 1 fig. Chart showing signal indications for each run as train approaches.

Intermittent-Contact Type. The Bourdette-Brookins Train Control System. Ry. Signal Engr., vol. 13, no. 10, Oct. 1920, pp. 411–413, 7 figs. System is of intermittent electrical contact type.

TRAIN LIGHTING

Lamps for. Essentials of Train Lighting. Bul. Eng. Dept. Nat. Lamp Works, Gen. Elec. Co., bul. no. 10D, Oct. 27, 1919, 16 pp., 13 figs. Sug-

ENGINEERING INDEX (Continued)

gestions as to proper use of Mazda lamps for train lighting. Technical data of lamps.

TRANSPORTATION

Land vs. Water Routes. Comparison of Cargo Transportation by Land and Water Routes, William T. Donnelly. Marine Eng., vol. 25, no. 11, Nov. 1920, pp. 899–803, 5 figs. System for prompt dispatch of cargoes by inland water routes. Fleets of separately propelled vessels travel together in convoy with central electric generating station afloat connected to fleet by cable and with all propellers driven by electric motors. Such a system is found to be more economical than any of land systems.

Steam Vehicles. Road Transportation by Steam-Vehicles, P. W. Robson. Jl. Instn. Mech. Engrs., no. 6, Oct. 1920, pp. 639–661 and (discussion) pp. 661–672, 9 figs. Sees steam motor wagon "as the most economical and reliable form of road transport."

TUBES

Manufacture. Manufacturing Steel and Iron Tubes, H. C. Ebright. Blast Furnace & Steel Plant, vol. 8, no. 11, Nov. 1920, pp. 609–612, 3 figs. Youngstown sheet and Tube Company's method of manufacturing pipe processes used in forming and welding steel tubes. Process of threading, testing and finishing.

Narrow, Riveting. Riveting of Narrow Tubes. Eng. and Indus. Management, vol. 4, no. 15, Oct. 7, 1920, pp. 456–457, 18 figs. Method of riveting narrow tubes from inside. Translated from Luftfahrt, and circulated by British Air Ministry.

TUNNELS

Construction Methods. Tunnels—XXVI. Ry. Engr., vol. 41, no. 489, Oct. 1920, pp. 426–430, 11 figs. Construction methods adopted in Rogers Pass tunnel made by Canadian Pacific Railway in 1913–1915 in British Columbia, and at Twin Peaks tunnel, provided for new highway near San Francisco, Cal.

TURBO-GENERATORS

Small. Small Steam Turbines (Kleindampfturbinen), Werner Bergs. Prometheus, vol. 31, nos. 49 and 50, Sept. 4 and 11, 1920, pp. 385–387 and 395–398, 8 figs. Describes construction by Brown-Boveri & Co. Corp., Mannheim, of small direct-current turbine group for lighting purposes; output: 500 watt, 110 volt, speed 4500 r.p.h.; length, 530 mm.; width, 280 mm.; height, 360 mm.; weight, 75 kg. Details of other BBC small steam turbines for output of 20 to 100 kw., 100 to 500 kw., etc. Points out advantages of small steam turbines in comparison to piston steam engines of the same capacity.

Steel Foundations for. Steel Foundations for 30,000-Kilowatt Horizontal Turbo-Generators, J. R. James. Power, vol. 52, no. 17, Oct. 26, 1920, pp. 646–649, 3 figs. Steel foundations for 30,000-kw. turbo-generators recently installed by Detroit Edison Co. Reduction in weight of about 500 tons was effected, difference in cost was negligible and operation has shown almost no perceptible vibration.

TURPENTINE

Data on. Turpentine: Its Sources, Properties, Uses, Transportation, and Marketing, with Recommended Specifications, F. P. Veitch and V. E. Grotlisch. U. S. Dept. Agriculture, bul. no. 898, Nov. 8, 1920, 51, pp., 7 figs.

V

VACUUM TUBES

See ELECTRON TUBES.

VAPOR PRESSURES

Measurement of. A Method of Measuring Low Vapor Pressures, with Its Application to the Case of Trinitro-Toluene, Alan W. C. Menzies Jl. Am. Chem. Soc., vol. 42, no. 11, Nov. 1920, pp. 2218–2221. Method is outlined by which low vapor pressures may be measured with single McLeod gage.

VENTILATION

Ventilators. Recent Tests on Automatic Ventilators, A. J. Mack. Heat. and Vent. Mag., vol. 17, no. 10, Oct. 1920, pp. 27–29, 3 figs. Results of tests indicated that siphoning ventilators have advantage over non-siphoning types.

[See also HEATING AND VENTILATION.]

VOCATIONAL EDUCATION

Psychotechnical Tests. Fundamental Principles of the Psychotechnical Examination of Industrial Students (Grundsätze der psychotechnischen Lehrlingsprüfung), W. Moede. Werkstattstechnik, vol. 14, no. 16, Aug. 15, 1920, pp. 433–441, 14 figs. Notes on adaptability tests of students and success of such tests at the psychotechnical laboratory of the Charlottenburg High School.

VOLTAGE REGULATION

Step Induction Regulator. The Step Induction Regulator, E. E. Lehr. Elec. Jl., vol. 17, no. 11, Nov. 1920, pp. 510–514, 4 figs. Structural details of apparatus and method of connecting it.

VULCANIZATION

New Process. The New Process for the Vulcanization of Rubber, S. J. Peachy. India Rubber Jl., vol. 60, no. 17, Oct. 23, 1920, pp. 25–26. Cold cure process. It consists in exposing rubber, alone or in admixture with practically any useful filling agent or pigment, successively to action of two gases, sulphur dioxide and hydrogen sulphide. Gases diffuse into rubber and there interacting produce active form of sulphur which is capable of combining with and vulcanizing rubber at ordinary temperature.

W

WAGES

Minimum. Food Requirements and the Minimum Wage. Nature (Lond.), vol. 106, no. 2661, Oct. 28, 1920, pp. 284–286. Based on figures compiled by Food Committee of Royal Society.

WALLS

Concrete. A New System of Hollow Concrete Wall Construction, Charles Alma Byers. Building Age, vol. 42, no. 11, Nov. 1920, pp. 31–32, 3 figs. System designed and patented by Charles B. Harp, construction engineer of Los Angeles, California. Walls are erected with pre-cast concrete slabs which are set edgewise in two tiers to form continuous air space.

WARSHIPS

Cruisers. The Light Cruiser Raleigh. Engr., vol. 130, no. 3381, Oct. 15, 1920, pp. 374–375, 1 fig. Characteristics: Length overall, 605 ft.; extreme breadth, 65 ft.; mean draft, 17 1/4 ft.; displacement, 9750 tons; horsepower, 70,000; speed, 31 knots; armament, seven 7 1/2-in. and twelve 12-pdr. guns, and six torpedo tubes.

Ex-German. The Ex-German Battleship Baden. Engr., vol. 130, no. 3379, Oct. 1, 1920, pp. 319–322, 13 figs. partly on supp. plate. Structural details.

Superdestroyers. The "Super-Destroyer," Hector C. Bywater. Sci. Am., vol. 123, no. 19, Nov. 6, 1920, pp. 472 and 482, 2 figs. Functions of flotilla leader as contained in recommendations made by General Board of U. S. Navy for building program of 1921.

WATER FILTRATION

Research. The Rapid Filtration of Water, Alexander C. Houston. Engr., vol. 130, no. 3375, Sept. 3, 1920, pp. 218–220, 3 figs. Thirteenth Research Report issued by director of Water Examination of Metropolitan Water Board, London. It is principally concerned with question of how far rapid filtration of stored river water is capable of producing supplies which are safe and suitable for human consumption.

WATER HAMMER

Metallic Conduits under Pressure. Study of Water Hammer in Metal Conduits under Pressure (L'étude des coups de bélier dans les canalisations métalliques sous pression), C. Camichel and D. Eydoux. Houille Blanche, vol. 19, no. 43–44, July-Aug. 1920, pp. 127–131, 3 figs. Formulæ for determining velocity of transmission, pressure exerted, etc., and graphs indicating transmission of water hammer. (Continuation of serial.)

WATER GAS

Automatic Controller. Ensuring a Constant Quality of Water Gas. Gas World, vol. 73, no. 1891, Oct. 16, 1920, pp. 297–298, 1 fig. Automatic controller manufactured by Davison and Partner, London, England.

WATER METERS

Design. Defects in Current Meters and a New Design, Samuel Fortier and E. J. Hoff. Eng. News-Rec., vol. 85, no. 20, Nov. 11, 1920, pp. 923–924, 2 figs. Meter developed to meet requirements of relatively low velocities and small channels.

WATER POWER

Federal Power Commission. Commission Drafts Its Rules. Bul. Water Power League of America, vol. 1, no. 2, Aug. 1920, pp. 9–14. Rules and regulations which will govern work of Federal Power Commission created under Federal Water Power Act.

Palestine. Production of Electricity in Palestine by Utilizing Water of Mediterranean Sea (L'elettrificazione della Palestina), A. Gradenwitz. Industria, vol. 34, no. 10, May 31, 1920, pp. 270–271, 2 figs. Level of Mediterranean is 1297 ft. above that of Dead Sea. Their nearest distance apart is less than 43 miles. A tunnel along this line is proposed.

Resources in U. S. Development of National Water-Power Resources, C. D. Wagoner. Elec. Rev. (Chicago), vol. 77, no. 19, Nov. 6, 1920, pp. 717–720, 3 figs. Analysis of developed and undeveloped water powers in U. S.

South America. Electrical Possibilities in South America, Verne Leroy Havens. Elec. World, vol. 76, no. 15, Oct. 9, 1920, pp. 729–730. Opportunities for water power development. Operating difficulties and how they are overcome.

United States. Potential Water Powers. Bul. Water Power League of America, vol. 1, no. 1, July, 1920, pp. 5–6 and 24. Total possible water developments on the 4325 miles of river channels included in present navigation projects over which Federal Government retains jurisdiction for navigation purposes, are estimated to amount to at least 10,200,000 hp.

WATER SUPPLY

Cleveland. Planning the Future of the Cleveland Water Supply, A. V. Ruggles. Eng. News-Rec., vol. 85, no. 19, Nov. 4, 1920, pp. 886–889, 4 figs. Methods followed lead to $30,000,000 program by 1940 delivering 430,000,000 gallons daily from four intakes of which two will be new.

WATER WORKS

Cost-Plus Contracts. Cost-Plus Contracts for Water Works Construction, George W. Fuller. Jl. Am. Water Works Assn., vol. 7, no. 5, Sept. 1920, pp. 683–692. It is held that cost plus contracts, with proper provision for accounting and suprvision, may be satisfactory where conditions are not definitely known and in case of private corporations where well qualified contractors may be selected to work under adequate supervision. Under war conditions, it is said, cost-plus contracts were necessary and even now have many advantages.

WATERWAYS, INLAND

Reconstruction. The Reconstruction of French Inland Waterways (Pour la reconstruction de notre réseau navigable), J. Boudet. Vie Technique & Industrielle, vol. 1, no. 12, Sept. 1920, pp. 463–472, 7 figs. Method of "isolated sections" for reconstructing waterway without interrupting traffic. Special portable dams are firmly placed about 600 ft. apart; water is pumped out from section thus isolated and work required performed over night. Method was invented by Enterprise Fougerolle and is said to have been applied successfully by them in various enterprises.

WAVE POWER

Wave-Motion Turbine. Wave-Motion Turbine, Arthur Palme. Power, vol. 52, no. 18, Nov. 2, 1920, pp. 700–701, 4 figs. Scheme for utilization of wave motion, in operation for some time at Royan, France.

WELDING

Steel, High-Speed. The Welding and Brazing of High-Speed Tool Steel with Carbon-Steel (Verschweissen und Verlöten von Schnelldrehstahl mit Kohlenstoffstahl), Rudolf Schäfer. Zeit. für Dampfkessel u. Maschinenbetrieb, vol. 43, no. 32, Aug. 6, 1920, pp. 241–244, 6 figs. Sets forth relative merits of welding and brazing. It is shown by numerous examples that a perfect adhesion of high-speed tool steel points to carbon-steel shanks can be effected by welding or brazing and that the electric welding process is most advantageous.

[See also AUTOGENOUS WELDING; ELECTRIC WELDING; ELECTRIC WELDING, Arc; ELECTRIC WELDING, Resistance; OXY-ACETYLENE WELDING.]

WELDS

Tests. Testing Steel Plate Welds. Iron Age, vol. 106, no. 20, Nov. 11, 1920, p. 1265. Methods for quickly determining general character of work. (Abstract.) Paper read before Am. Welding Soc.

Testing Welds, S. W. Miller. Acetylene Jl., vol. 22, no. 5, Nov. 1920, pp. 258–263 and p. 295, 26 figs. Also Welding Engr., vol. 5, no. 10, Oct. 1920, pp. 26–36, 26 figs. Methods of testing. Paper read before Am. Welding Soc.

WIND TUNNELS

Germany. Report on German Wind Tunnels and Apparatus, Edward P. Warner. Aerial Age, vol. 12, no. 10, Nov. 15, 1920, pp. 275–277, 2 figs. Description of wind tunnels at Göttingen, Aachen, Dessau and Friedrichshafen together with methods of operation and details of apparatus used. (To be continued.) Report of Nat. Advisory Committee for Aeronautics.

Resistance Equation. Air Forces on Circular Cylinders, Axes Normal to the Wind, with Special Reference to Dynamical Similarity, Hugh L. Dryden. Sci. Papers, Bur. of Standards, no. 394, Sept. 4, 1920, pp. 489–519, 10 figs. Experimental study of general wind tunnel resistance equation.

WIRING

Earthing. Earthing. Jl. Instn. Elec. Engrs., vol. 58, no. 292, June 1920, pp. 468–475 and (discussion) pp. 476–490, 4 figs. Report of earthing sub-committee of Wiring Rules Committee, appointed to "consider the whole question of earthing, including the time element of circuit-breakers, the heating of conductors, the current-carrying capacity of the apparatus earthed, the drop of pressure in metal sheathing, and the number of earth wires required."

WOMEN WORKERS

Management of Women. The New Place of Women in Industry—II, Ida M. Tarbell. Indus. Management, vol. 60, no. 5, Nov. 1920, pp. 329–330. Discusses successful utilization of women workers.

WOOD PRESERVATION

Charring. Charring Does not Preserve Wood. Forest Products Laboratory, Technical Notes, Oct. 15, 1920, no. 108, 1 p. Tests showed that charring deep enough to resist decay would undoubtedly weaken post of ordinary size.

Preservative Treatment. Water Solubility a Necessary Property of Wood Preservatives. Forest Products Laboratory, Technical Notes, Oct. 15, 1920, no. 114, 1 p. That any substance to be effective wood preservative must be soluble in water at least to extent of producing toxic water solution is basis of theory now being developed at U. S. Forest Products Laboratory.

WORKMEN'S COMPENSATION

U. S. and Canadian Laws. Comparison of Workmen's Compensation Laws of the United States and Canada up to January 1, 1920, Carl Hookstadt. U. S. Dept. of Labor, Bur. of Labor Statistics, no. 275, Sept. 1920, 140 pp. Covers all laws enacted up to January 1, 1920.